POWER TRANSMISSION DESIGN

APRIL 1959

OEM··MAINTENANCE

How To Select A Silent Chain Drive

Modular Drive With Interchangeable Change Gears

How To Cope With Critical Speeds

Electronic Control Of Shaft Position

When To Use Centrifugal Clutches

THE MAGAZINE OF MACHINE DRIVES

News and Ideas for designers and plant engineers who use power drive equipment

CONWAY CLUTCHES

"The Clutch of Robust Refinement"

• *"A Splendid Clutch in 1928"* • *Infinitely Improved in 1959*

Innumerable veteran Conway Clutches are still doing a productive job because of honest materials and skilled, conscientious craftsmanship.

Standing still is not the Conway way of doing things . . . what is good today must be *better* tomorrow.

For example: the clutch at the left was built in 1928 and has been in operation since *without replacement of a single part.* It still fits into modern plant operation. *The 1959 version, of course, is vastly improved.*

Conway Clutches { **for the transmission of power for all industry**

• *Write for bulletins and engineering help.*

the CONWAY CLUTCH CO.

2754 Colerain Ave. • **Cincinnati 25, Ohio**

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maurey DRIVES

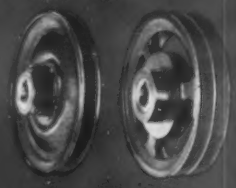
deliver more "giddap" per horse

You put more productive "giddap" into any machine when you install a Maurey V-Drive or a Maurey Roller Chain Drive. Maurey Drives deliver the full horsepower from the motor to the machine. It's a double advantage, to have Maurey drive engineering and the complete Maurey line at your disposal as you plan. For here, in one place, is the answer to the whole drive problem . . . engineering, the right pulleys, the right V-Belts, the right sprockets and the right roller chains. So . . . whether you are designing a new drive, or improving an old drive, get the solid help Maurey can give you. It's the sure way to end up with the one drive that is right for the job to be done.

Call your local Maurey Distributor, or write direct for any of these catalogs

FHP V-Drive Catalog F-10 . . . V-Belt Catalog No. 55 . . . Multiple V-Drive Catalog No. MVD-58 . . . V-Drive Engineering Manual . . . Maureymatic Variable Speed Transmission Catalog No. MM-58 . . . Roller Chain Drive Catalog D-58 . . . Conveyor Pulley Catalog No. CV-1 . . .

maurey THE COMPLETE, ENGINEERED DRIVE LINE



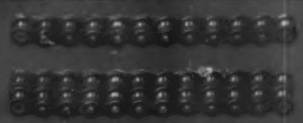
Hi-Q FHP V-Pulleys

FUL-GRIP Q-D Sheaves

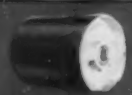
Mor-Grip Green Seal V-Belts

Maureymatic Variable Speed Transmissions

Sprockets



Roller Chains



Conveyor Pulleys

And a complete line of Drive Accessories

maurey MANUFACTURING CORPORATION

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Fast Service From These Maurey Warehouses

CLEVELAND: 3200 Lakeside Avenue • Phone: MAin 1-2242 • **KANSAS CITY, Mo.:** 1728 Walnut • Phone: BAltimore 1-3330

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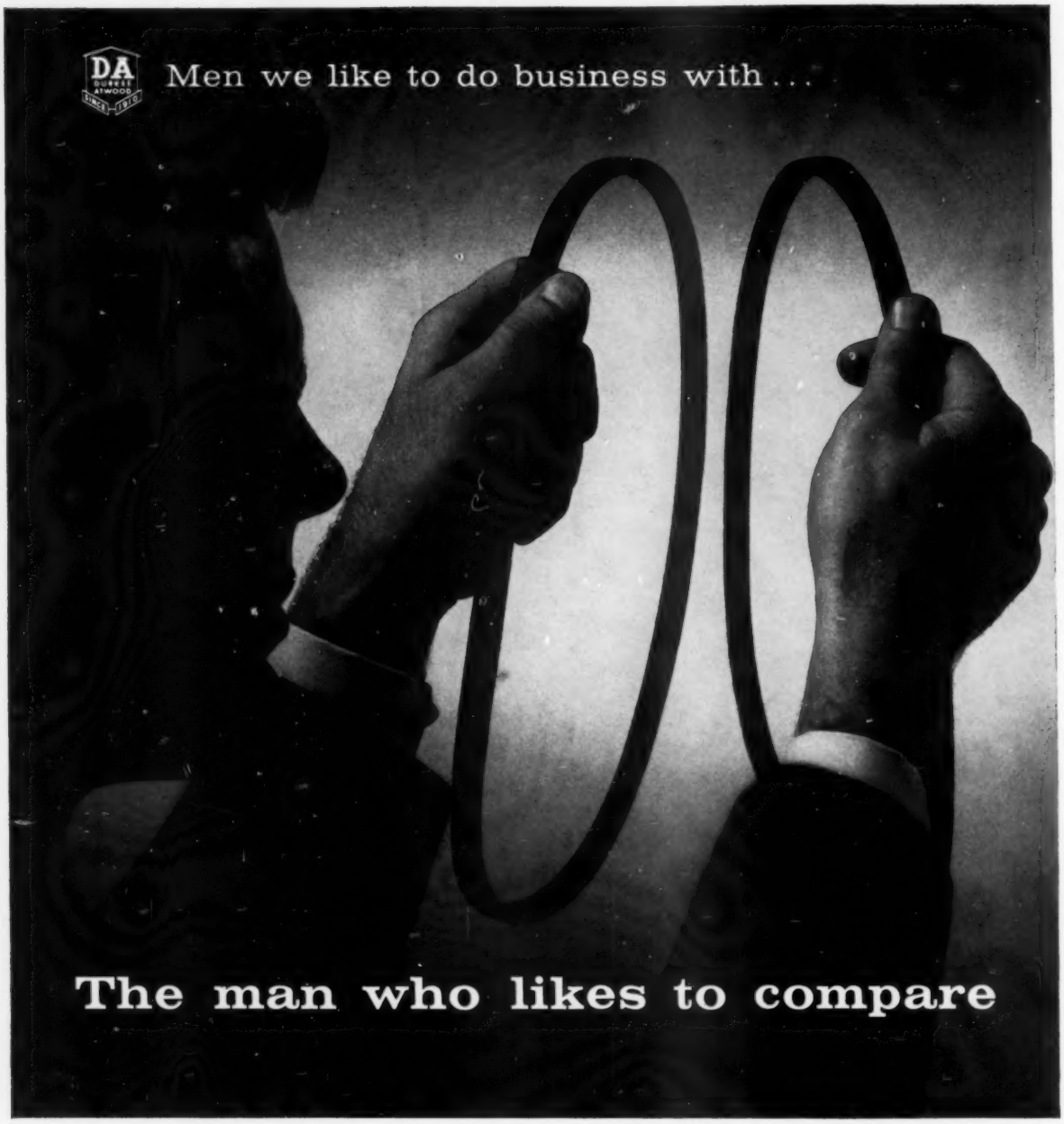

The men who specify and buy for industry are constantly comparing one brand or product against others in the field. But there are some who examine different products just a little more carefully than others, who ask special questions about quality, engineering features, durability, service, comparative costs and many other factors.

They are people we like to do business with!

The reasons? We can prove, in specific and understandable terms, the advantages of Durkee-Atwood V-Belts. We can show them *Quality* that meets the most demanding needs of industry, that long usage under difficult conditions has proven . . . prompt *Service* when special attention and help are needed . . . and real money *Savings* (that's where comparison really counts).

Durkee-Atwood, one of America's pioneer V-Belt manufacturers, offers a complete line of Multiple V-Belts, General Duty V-Belts and Steel Cable V-Belts—built to last and *last*!

DURKEE-ATWOOD V-BELTS

DURKEE-ATWOOD COMPANY • MINNEAPOLIS 13, MINNESOTA

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April 1959, *volume 1 number 4*

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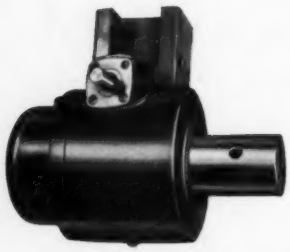
FACTS

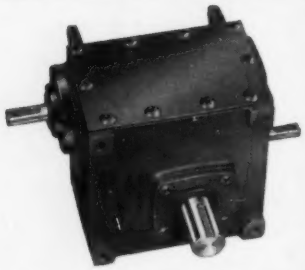
and figures on products and literature of interest to designers, engineers, and other power transmission design people can be had by circling the right numbers on the reader service cards found opposite page 48.

Special OHIO SPEED REDUCERS

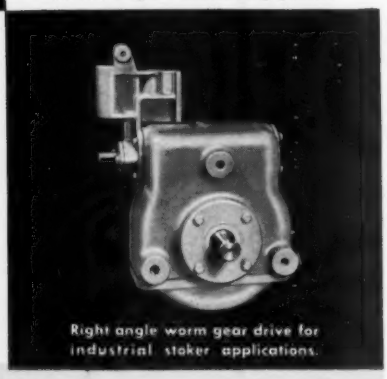
Combination planetary and worm gear reducer for resetting circuit breakers in electrical power stations.



Heavy duty, hand-operated reducer with overload clutch used in automotive engine machining plants.



Combination clutch and speed reducer for powering mechanical bowling pinsetter. Input shaft turns constantly.



Right angle worm gear drive for industrial stoker applications.

"Engineered" To Your Specifications

• If the design of your machine calls for a *special* speed reducer . . . OHIO is the place to get it! An experienced staff of power transmission engineers can help you modify a standard reducer to solve your problems or, design and build an entirely new speed reducer to meet the demands of your application.

With more than 40 years experience in the design and manufacture of power transmission equipment, you can depend on OHIO for efficient, economical solutions to all your *special* speed reducer needs.

Get Your Free Catalog— 186 pages packed with useful information on gears and speed reducers

Manufacturers of gears and speed reducers - both stock and special

Ohio **OHIO GEAR Co.**
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Rockwell-Standard and J. I. Case Work Together to Design Custom Drive For The New "1000" Combine

When engineers from the J. I. Case Company designed this big-capacity, self-propelled combine—they aimed at new high standards of performance. Specifications called for a special drive, as well as other special components.

That's when the J. I. Case Company brought the drive specifications to Rockwell-Standard Corporation engineers. Here, experienced axle engineers studied the needs . . . and produced a specially designed Timken-Detroit® drive that met *all* the J. I. Case specifications. A drive that *really* puts power to work.

Once again, Rockwell-Standard proved it is more economical for builders of special equipment to draw on specialists for their special needs.

If you have a problem in designing or building self-propelled drives, call in Rockwell-Standard axle engineers. It costs you nothing, and will undoubtedly prove very helpful in saving you both time and money.

TIMKEN Detroit AXLES
ROCKWELL-STANDARD CORPORATION
TRANSMISSION AND AXLE DIVISION
DETROIT 32, MICHIGAN
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ANOTHER PRODUCT OF **ROCKWELL-STANDARD** CORPORATION

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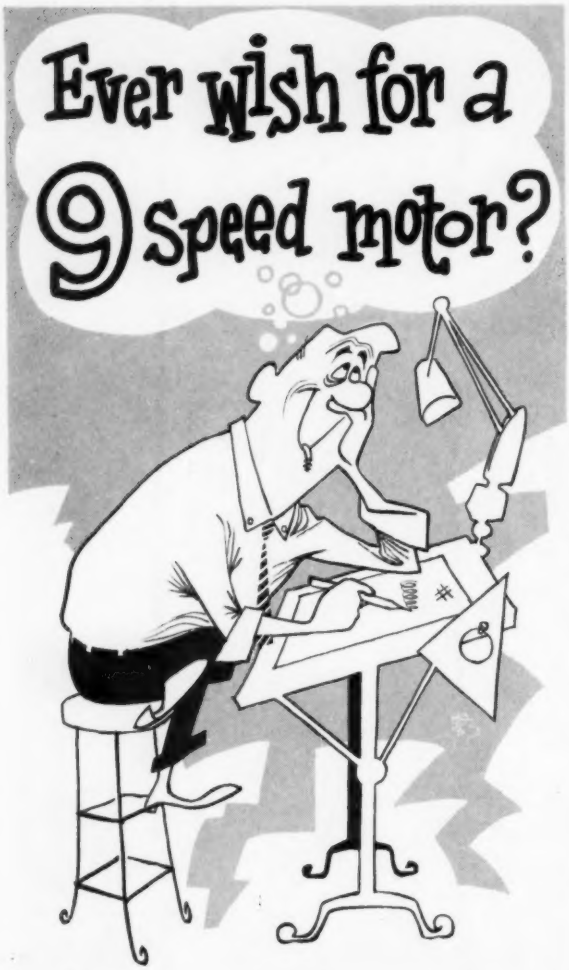
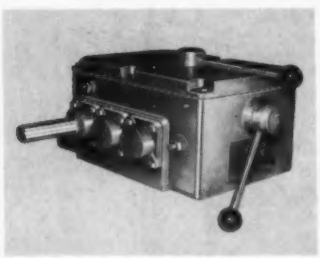


TRY TURNER



For 35 years Turner engineers have helped designers solve their transmission problems. Only Turner offers up to 9 exact output speeds from 1 constant input speed. All this, in one compact rugged unit. Is your problem unique? All the more reason you should Try Turner.

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TURNER TRANSMISSIONS
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Phone Logan 1-6800

Circle No. 25 on the Reader Service Card

LETTERS to the editor

Address letters to:
The Editor
Power Transmission Design
812 Huron Road, Cleveland 15, Ohio

Gentlemen:

. . . . . have seen copies of your publication and would be interested in receiving it regularly.

E. C. LEVIT
Vice President—engineering
Yard-Man, Inc.
Jackson, Michigan

Gentlemen:

I have received the January 1959 issue of Power Transmission Design and found it to be of great value to our company. However, I have not received the February issue. If it is possible, please continue to send all the issues of this fine publication. We certainly do appreciate the excellent work your organization is accomplishing in this related field.

GARY ADAMS
Welding engineer
The Patterson-Kelly Co., Inc.
East Stroudsburg, Pa.

• *Sir:*

Please accept our deepest apologies for the first two issues of POWER TRANSMISSION DESIGN being received so late.

Gentlemen:

We note with pleasure your presentation of our RT Fittings on page 56 of the January issue. However, the illustration was inadvertently shown in an inverted position. The fitting is designed to replace conventional drain plugs inserted at the bottom of an electric motor bearing and also used in some pillow block and other machine bearings.

F. D. STREET
Sales Manager
Keystone Lubricating Co.
Philadelphia

Gentlemen:

Now that two issues of your new magazine are out, we are glad to report that we have had very excellent comments from many people and that we here feel this magazine is excellent and filling a much needed requirement in the power transmission field.

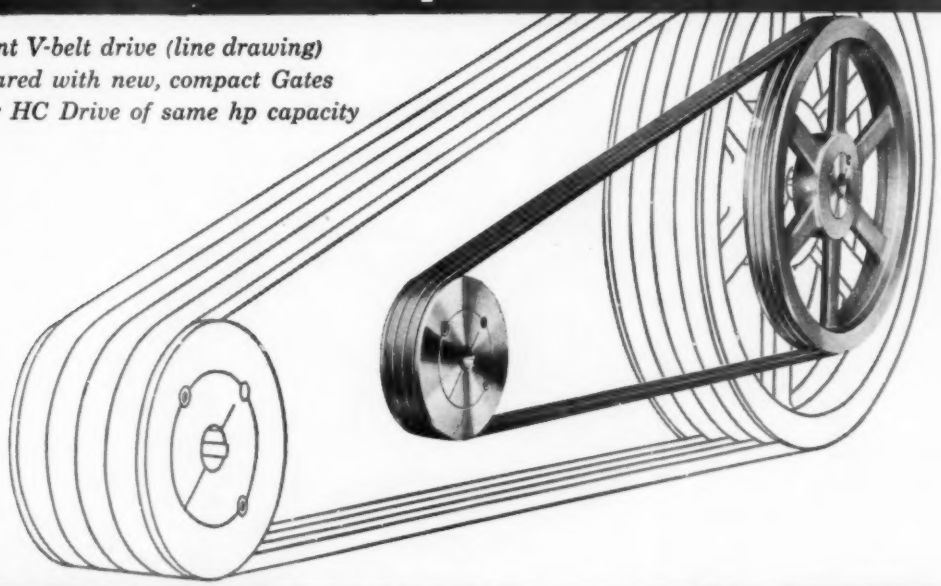
INGRAM DICKINSON
President
Southern Belting & Transmission Co.
Atlanta

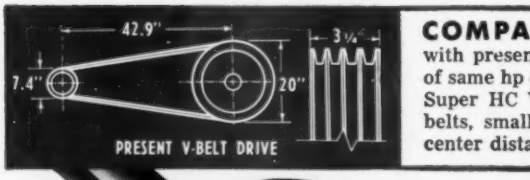
• *Sir:*

May we take this formal opportunity to thank you and all other readers who sent their best wishes and kind remarks about our first issues. We are deeply moved by this tumultuous reception and hope we can merit your continued interest in our magazine.

up to 50% LESS SPACE needed for revolutionary new V-belt drive

Present V-belt drive (line drawing) compared with new, compact Gates Super HC Drive of same hp capacity





COMPARE: Left, typical drive with present V-belts. Right—drive of same hp capacity with Gates new Super HC V-Belts . . . uses fewer belts, smaller sheaves and shorter center distance.

Exclusive cross-section design: The precisely engineered arched top, concave sidewalls (U. S. Pat. 1813698) and special tensile construction insure full pulling power and longer belt life.

Reduces drive cost as much as 20%

A major advance in the field of power transmission, the fully proved Gates Super HC V-Belt, makes possible the lowest-cost, lightest-weight, most compact multiple V-belt drive that can be put on any machine!

The cost of a new Gates Super HC V-Belt Drive is as much as 20% less than present V-belt drives of the same hp capacity.

For detailed information on the Super HC Drive, contact your nearby Gates distributor or Gates Office for new booklet, *"The Modern Way to Design Multiple V-Belt Drives."*

TPA 389

The Gates Rubber Company, Denver, Colorado

Gates Rubber of Canada Ltd., Brantford, Ontario

World's Largest Maker of V-Belts

Gates Super HC V-Belt Drives

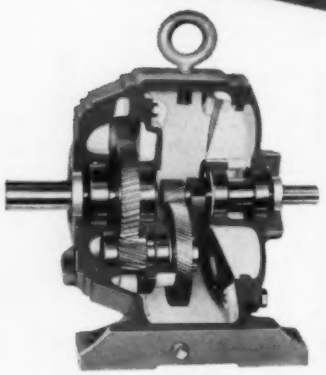
For more information circle No. 12 on the Reader Service Card

Now from Jones

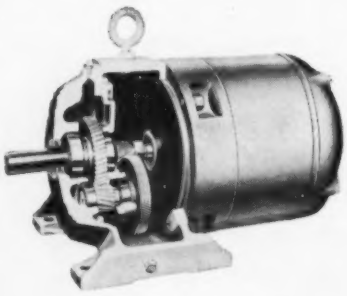
SPEED REDUCERS

NEW! Jones All-Motor Type Gearmotors

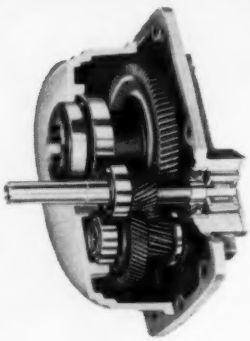
Designed with high-hardness gearing for longer life. One-piece low speed end housing construction insures gear alignment and prevents oil leakage. Compact design. All three types available for foot-mounted or flange-mounted installation, and for horizontal or vertical application. Capacity is up to 250 hp.



NEW!
Jones In-Line Helical Reducers



NEW!
Jones Integral Type Gearmotors



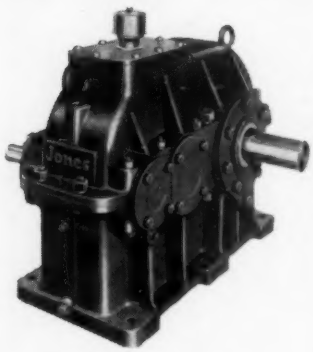
NEW! Jones Shaft-Mounted Reducers

High-hardness gearing gives compact design and extra service life. Positive sealing against oil leakage through double lip type seals. All gearing straddle-mounted between anti-friction bearings. Single and double reduction units to 40 hp. Six standard sizes. Flange-mounted units available in three standard sizes.

FOR EVERY PURPOSE!

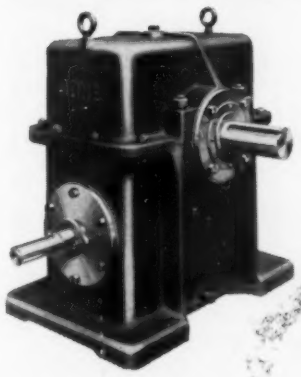
One of the most comprehensive speed reducer lines in industry! With new shaft-mounted reducers, in-line helical reducers, and gearmotors, Jones now offers a wide selection for all your power transmission needs. New technical bulletins give you exactly the information you need for proper selection of units in accordance with latest A.G.M.A. ratings. Be sure to ask your Jones representative for copies, or write Hewitt-Robins, Stamford, Connecticut, for this literature:

All-Motor and Integral Type Gearmotors . Bulletin 4-22-J17
In-Line Helical Reducers . . . . . Bulletin 4-22-J18
Shaft-Mounted Reducers . . . . . Bulletin 4-22-J19
Herringbone Gear Reducers . . . . . Bulletin 4-22-100
Worm Gear Reducers . . . . . Bulletin 4-22-J13
Worm-Helical Reducers . . . . . Bulletin 4-22-J14



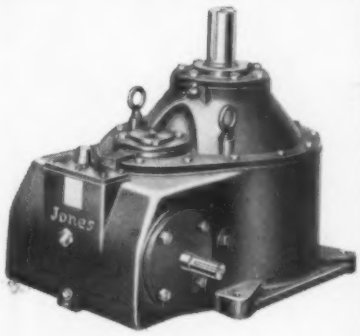
Jones Herringbone Gear Reducers

Accepted throughout industry; balanced design, heavy-duty roller bearings, rugged cast iron housing for reliable service and low maintenance costs. The most complete parallel shaft line in industry.



Jones Worm Gear Reducers

Horizontal and vertical shaft types available with ratios to 80:1. Heavy-duty roller bearings throughout with high-test cast iron housings for positive gear alignment.



Jones Worm-Helical Reducers

For vertical output shaft service; ratios from 25.63:1 to 357.5:1. Provide optimum combination of initial cost, efficiency, and low maintenance. Proven in hundreds of installations; redesigned to incorporate latest improvements in metallurgy and reducer design.

HR HEWITT-ROBINS

THE NAME THAT MEANS EVERYTHING IN BULK MATERIALS HANDLING SYSTEMS . . .

CONVEYER BELTING AND IDLERS • POWER TRANSMISSION DRIVES • INDUSTRIAL HOSE • VIBRATING CONVEYORS, SCREENS & SHAKEOUTS

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New hot room tests whole machines

SCHENECTADY, N. Y.—A 22 by 12 by 10 ft room at General Electric Co's. General Engineering Laboratory will let entire machines be exposed to radiation, while operating. Normally, in radiation testing, the test object is placed in a sealed cylinder with the radioactive source. This limits the size so that only part-by-part tests can be run.

Radiation source is 10,000 curies of Cobalt 60. This is in a metal basket at the bottom of 16 ft of super-purified water to provide shielding when testing is not under way. Special controls outside 4-½-ft-thick walls raise the basket to the top of the well to increase radiation level. Radiation rate is up to 500,000 roentgens an hour. The most radiation a human being can take is about 0.007 roentgens per hour.

Test specimens can be watched through a water-filled window in the 4-½-ft wall or on closed-circuit television. Electrical cables also permit extensive instrumentation to be used to keep tab on what's happening. Instruments that must be placed inside the room can be observed with the closed-circuit TV.

NEW HOT ROOM with a motor to be tested on the floor. Closed-circuit TV camera is on a tripod in the corner.

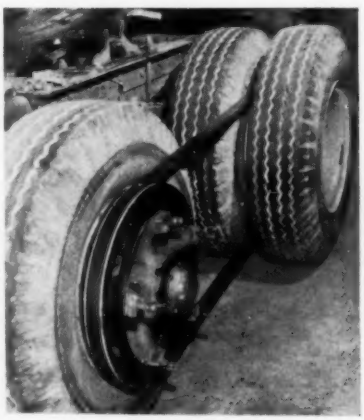
LONG TONGS let technician manipulate the slabs of cobalt 60 in a basket at the bottom of 16 ft of super-pure water.

Making dual axle drive the easy way

DAYTON, OHIO—You can put power on both axles of a tandem dual set quickly and easily with a new, inexpensive, V-belt drive. The new drive will transmit as much as 85 percent power to the non-powered axle.

The sheaves of the V-belt slide directly onto a spoke-type wheel, or on the lugs of a disc-type wheel. Special slots in the bottom of the sheave groove provide a clean-out for dirt and snow as the wheel turns, and a rapidly vibrating de-icer band of synthetic rubber and cord, mounted in the bottom of the sheave groove, breaks up ice and snow so they can be scattered through the slots. Total weight of the new V-belt and sheaves is about 200 lb, considerably less than that of other driving devices.

Not only will the tandem drive give better traction for hauling extra-heavy loads, also by reducing slipping and equalizing braking action between the two axles, it will double or triple tire life on the powered wheels and increase brake-lining life, says the manufacturer, Dayton Rubber Co. The drive is expected to have a service life of 75,000-100,000 hr, virtually maintenance-free.



ASA sets up bearing code

NEW YORK, N. Y.—A simple code that will permit users and manufacturers of antifriction bearings throughout the world to talk about bearings in a common language has moved a step closer to reality.

The American Standards Assn.'s Sectional Committee B54, after thirteen years of committee work, has agreed on a new alpha-numerical identification system which concisely describes the tolerances, lubrication and physical features of standard ball and roller bearings. It's expected that the new standard will be published later this year, after processing through the approval procedures for American standards.

Development of this new standard code has been tied in with similar work in the International Organization for Standardization, and there is practically complete agreement between the proposed American standard and the proposed ISO code. The Anti-Friction Bearing Manufacturers Assn. sponsored the ASA project, and its members have said they will use the new code when it is approved.

Miniature motors have new maker

DAYTON, OHIO—All dies, fixtures, parts, etc. formerly used by GE at Fort Wayne to make certain wound-field and perminent-magnet motors have been purchased by Globe Industries Inc., Dayton, O. Model designations are: 5BBY9, 5BBY13, 5BN14, 5 PD14, 5 PG18, and 5BBY-10. These motors will be manufactured and sold by Globe. They will sell suitable replacement motors for their applications to former GE customers. Frame sizes of these motors are 9, 10, 13, 14, and 18. Diameters range from 1-¼ to 2-¼ in.

Gear manufacturer expands

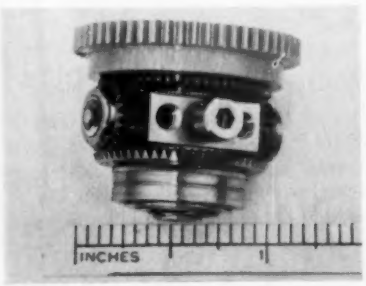
LYNWOOD, CALIF.—New offices for the Industrial Products Div., Western Gear Corp., Belmont, Calif., have been started. An additional 10,000 sq. ft. of space for engineering, sales, purchasing and accounting will be provided. Gearmotors and speed reducers are among products of the division.

New technique for mounting miniature gears

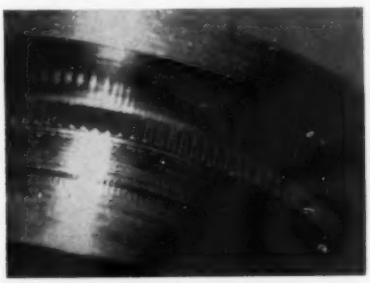
GLENDALE, CALIF.—A new broaching technique for mounting miniature gears resists severe torsion and tension and does not deform the gear concentricity. Librascope Inc. developed the technique originally to fasten miniature shafts to arms.

Typical of the places where the method is used to advantage is a miniature 2-pinion, differential used in analog computers and similar equipment. Here, tiny ring gears are mounted on bevel gear hubs. The ring gears are 1/8-in. wide aluminum or brass. Bevel gear hubs are No. 416 stainless steel with diameters of 0.5000 and 0.6880 in.

A fine pitch knurl, usually 80 pitch, is applied to the hub surface. A groove is then machined around the hub at the leading edge of the knurl. This forms sharp edges which let the knurling act as microscopic broaching teeth as the ring gear is pressed onto the hub. The groove also collects the material broached from the ring gear and prevents galling or spalling the metal. This connection will transmit 50 in.-lb torque, minimum.



MINIATURE DIFFERENTIAL uses knurl-broach technique to fasten ring gears to bevel gear hubs.



CHIP GROOVE machined across leading edge of knurling makes broaching teeth.

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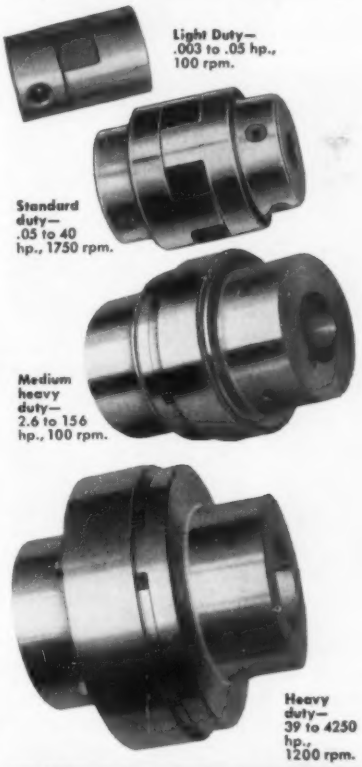

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MEN of the power transmission field

Timken veterans in new posts

RUNDT

GREEN

McKELVEY

HILL

NEIFERT

Timken Roller Bearing Co. has promoted Walter F. Green to general manager, Product Development Division, and John W. Rundt to assistant general manager and chief engineer. Both have been with the company since 1935.

Green started with the company as a tool designer in the Experimental Dept., transferring to the Works Engineering Dept. in 1936. In 1939 he was made assistant works engineer, and in 1946 assistant general manager of the Product Development Div. In 1947 he became manager, a position he held until his recent promotion. He is a past chairman of the Canton-Alliance-Massillon Section of the American Society of Mechanical Engineers and a member of the American Society of Tool Engineers.

Other new Timken appointments: Harry R. Neifert, chief engineer, Physical Laboratories; Ralph McKelvey, assistant chief engineer; and Raymond L. Hill, project engineer.

Maurey sales appointment

Ralph Mossberg has been named by Maurey Manufacturing Corp., Chicago, as district sales representative on V-belt drives, chain drives, variable-speed transmissions, and power transmission accessories in the Northern Illinois territory, including the north half of metropolitan Chicago. He succeeds Edward F. Sullivan who has been placed in charge of sales for New York and New Jersey.

U.S. Rubber names four

Donald L. Reid has been appointed to the newly-created post of regional sales manager, West Coast Branches, of U. S. Rubber Co.'s Mechanical Goods Div. Working from the company's Los Angeles branch, he will direct sales in 11 Western states. He had been district sales manager in Los Angeles.

The company's Engineered Rubber Products Dept., Passaic, N. J., has named Theodore D. Ernst as product manager and John J. Cullen as assistant product manager. They will operate out of Passaic. Both men joined the company in 1943.

Donald M. Mahady has been named Midwest belting engineer for the Mechanical Goods Div. Operating out of Chicago, he will cover that city, as well as the branches in Kansas City, Minneapolis, Tulsa, New Orleans, Houston and Dallas.

New Stephens-Adamson directors elected

Two executives of the Stephens-Adamson Mfg. Co., Aurora, Ill., have been elected to the company's board of directors. They are Roger W. Barton, export manager, and Ernest T. Rollins, treasurer.

Re-elected to the board were the

BARTON

ROLLINS

following, all executives of the company: M. A. Kendall, chairman; L. S. Stephens, president; D. L. Stephens, executive vice president; G. A. Freeman, president of Stephens-Adamson Mfg. Co. Ltd. of Canada; and C. B. Hurd, R. W. Brauer, F. S. Wells, A. D. Sinden, and R. C. Pierce, all vice presidents.

Ohio Carbon Names Two

Alexander Kuys has joined the engineering staff of Ohio Carbon Co., Cleveland. He came to the company from the General Electric Locomotive and Car Equipment plant, Erie, Pa. In another change, David I. Stoffel was named secretary of the company.

Warner Appointments

Manager of the new Government Projects Dept. at Warner Electric Brake & Clutch Co., Beloit, Wisc., is Reginald Whitson, who has been with the company since 1952. He has served as sales supervisor, Washington representative, West Coast regional manager, and manager of Management Services. Warner established the new department to strengthen its position in the government sales area.

In another appointment, William W. Keefer has been named controller. Before joining Warner, Keefer was employed by U. S. Steel as a methods analyst and served as a consultant with a management consulting firm.

Janette sales mgr. named VP

Dean W. Paul, general sales manager of Janette Electric Mfg. Co., Morton Grove, Ill., has been elected a vice president of the company. Janette, a wholly owned subsidiary of Victor Adding Machine Co., makes gear motors and speed reducers.

Western manager for Leland

Russell L. Moubray, formerly eastern district sales manager, has been named western regional sales manager for G. H. Leland, Inc., maker of rotary solenoids and selectors and stepping motors. Operating out of Leland's home plant in Dayton, he will be responsible for Leland sales west of the Mississippi and in the Chicago area.

New Chief Draftsman

Formsprag Co., of Warren, Mich., maker of sprag clutches used in overrunning, indexing and backstopping operations, has named Frank J. Bogucki chief engineering draftsman. He has been an engineer with Formsprag since 1955; before that he was with the Engineering Diecraft Co. and Rayco Engineering, Inc.

New Franklin Electric VPs

Franklin Electric Co., Inc., Bluffton, Ind., announces two promotions, designed to handle increasing sales and production of its line of motors: R. P. Nixon to vice president, Finances and Manufacturing; and A. C. BeVier to vice president, Marketing.

BEVIER

NIXON

Saco-Lowell Elections

Royden Walters, formerly executive assistant to the president of Saco-Lowell Shops, Boston, has been elected vice president. Before joining the company last year, he was with Long Manufacturing and Detroit Gear divisions of Borg-Warner Corp.

The Board of Directors has also elected two new directors: John E. Johnson, chairman of the board of Glascock Brothers Mfg. Co.; and Henry W. Harding, president of Laboratory for Electronics, Inc.

Cincinnati Rubber names VP

William V. Shakespeare has been elected a vice president of the Cincinnati Rubber Manufacturing Co., a division of the Thor Power Tool Co. With Thor since 1936, Shakespeare joined Cincinnati Rubber as assistant to the president in 1956, when it became a Thor division. Cincinnati Rubber makes conveyor and transmission belting, hose, rubber-covered rolls, and associated industrial rubber products.

Bendix Controls names Rep

Samuel Sico, Jr., has been appointed eastern field engineering representative for Bendix Industrial Controls Section of Bendix Aviation Corp. Operating out of Westfield, Mass., he will provide engineering assistance to users of Bendix numerical control systems in the Eastern and New England areas.

Group V.P. at Budd Co.

Philip W. Scott has been elected a group vice-president of the Budd Co., Philadelphia, Pa., with supervision over four of the company's divisions. Mr. Scott will be a member of the Budd Policy Committee in addition to having direct responsibility for the operations of the Nuclear Systems Division; Continental Diamond Fibre Corporation; Tatnall Measuring Systems Co.; and Krouse Testing Machine Co., the latter three wholly owned Budd subsidiaries.

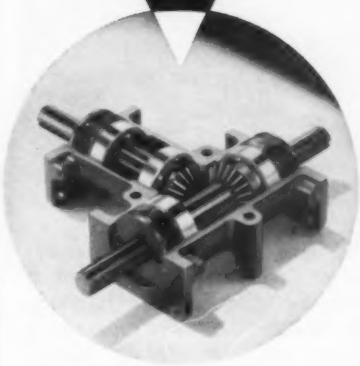
Will handle Swiss gears

Philadelphia Gear Corporation, Philadelphia, Pa., has signed an agreement with Maag Gear-Wheel Co., Ltd., Zurich, Switzerland, which will make available in this country Swiss-designed industrial gears providing precision tolerances. The agreement names Philadelphia Gear as exclusive agent for the manufacture and sale of Maag gear products in the United States and its territories.

New Dayton area man

Fred W. Ellis has been appointed foundry sales representative to the Dayton, Ohio, area for Climax Molybdenum Co., a division of American Metal Climax, Inc., New York City.

ANGLgear® simplifies your 90° drive problems



ANGLgear's hardened bevel gears and anti-friction bearings—exposed in the cutaway above—insure quiet, trouble-free operation. Being completely enclosed and permanently lubricated, unit requires virtually no maintenance.

Wherever you have a 90° power takeoff requirement in the ⅓ to 5 hp range, a standardized ANGLgear unit usually provides the simplest, most economical solution.

Compact, high-capacity ANGLgear offers you a number of advantages. Featuring universal mounting, it is easier to design into your power transmission systems; easier to install. Incorporating positive bevel gear drive, it eliminates slippage and minimizes backlash problems. Completely enclosed, it presents no safety hazard. Permanently lubricated, it requires little or no maintenance. And being standardized, ANGLgear is economically priced.

Standard ANGLgear is available from stock in ⅓, 1, 2¼ and 5 hp ratings, with choice of 1:1 or 2:1 gear ratios and 2 or 3-way shafting. See our literature in Sweet's Product Design File or contact our local distributor.

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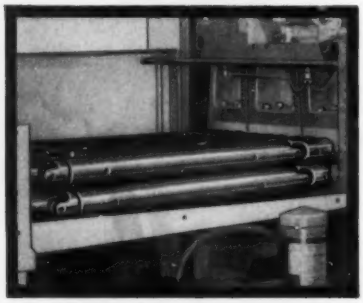
HOW CURTIS SOLVED A CLOSE CENTER-TO-CENTER PROBLEM



The close center-to-center spacing of these drive spindles on a Sutton-Maust Precision Backed-up Roller Leveler created a tough problem for its manufacturer. He needed a universal joint strong enough to stand up under heavy rolling mill conditions, yet small enough to operate at such close quarters.

The answer was a Curtis universal joint! The maximum load carrying capacity and minimum torsional deflection of the Curtis joint was found to be completely satisfactory. And Curtis' famous Telltale Lock Ring construction permits quick disassembly for easier maintenance.

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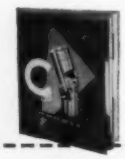

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EDITOR'S PAGE

David R. Cartwright
editor

Don't miss next month's Power Transmission Design

Our special issue . . .

. . . next month covers products to be shown at the Design Engineering Show, Convention Hall, Philadelphia, May 25-28.

To give you, our readers, absolutely first look at these products, we have contacted all exhibitors of the show and obtained photographs and information on the products they plan to display. You, then, will get first peek at all the power transmission products to be shown at the Show.

We'll also give you a brief layout of the show area to leave you with a feeling of having been there or to leave you with a greater feeling that you actually want to get there in person.

Why run so slow . . .

. . . when higher speeds are more economical and get work done faster.

Next month, we'll give you a revealing report on just what high speed means. Many of you will be surprised, just as we are, to learn how much of your slow-rotating machinery is losing money for you just like a slow-poke person does as opposed to someone who works fast and efficiently.

The Idea Articles . . .

. . . you read in the Idea Section of this magazine represents a big portion of the work load carried by our staff. Each of these articles, small as they are, compare with multiple-page articles you read elsewhere. Each represents a field trip and long editing hours by one of our editors. The net result is, you get a lot of facts on a few pages.

The people we visit to get this material are just like you, have the same job as you, have the same problems. You can help them by letting us in on some of your ideas you have working on actual machinery.

Nomographs appear in . . .

. . . every issue of POWER TRANSMISSION DESIGN. Be sure to save them because they are short cuts to solving a lot of problems. In fact, if you have a few of your own and wish to pass them along to other readers, shoot them in and we'll handle the rest. Or, if there are some problems you would like nomographed, let us know and we'll try to get them worked up.

Reader service cards . . .

. . . are for your convenience. Tear a card out before you start and circle the numbers of all products that interest you. Ask for reprints of articles you'd like to file or pass along to others. This is our way of being of service to you.

Dave Cartwright

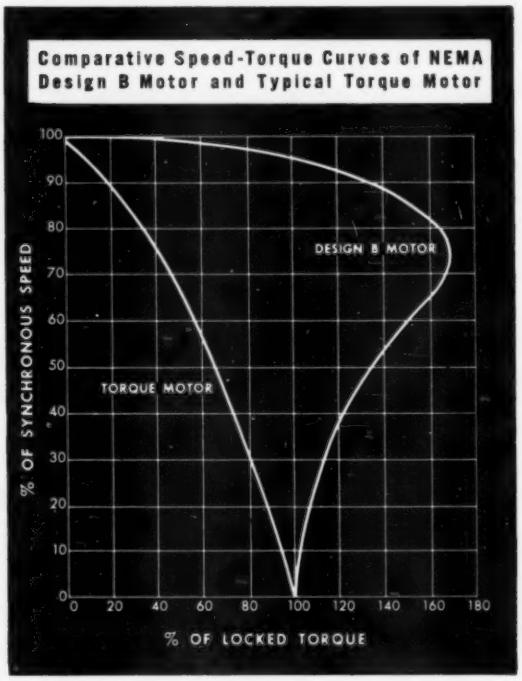
Editor

SELECTING TORQUE MOTORS

The torque motor, unlike any other electric motor, is a special from the word go. That situation alone makes Peerless one of the best sources for torque motors in ratings from 2 oz. in. to 200 lb. ft.

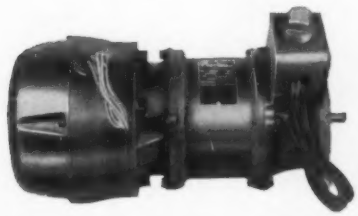
Torque motors deliver maximum rated torque without damage to the windings when stalled across the line at full voltage for predetermined periods. Peerless also builds torque motors which provide a nearly constant torque while operating at less than synchronous speeds.

All standard frame sizes; all types of mountings; high torques; special paint and varnish treatments; and Class A, B and H insulation are available from Peerless. Torque motors require unusually close cooperation between the motor supplier and the customer's engineers. This cooperation is a Peerless specialty. We will work with you to produce the one torque motor that powers your product best.

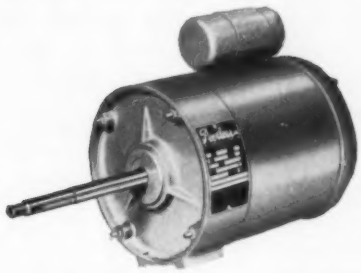


The speed-torque curve varies from that of a conventional motor. The torque motor curve is almost linear. Maximum torque occurs at the stalled position. For this reason, torque motors are used most often where a holding or resisting force is required.

Weather-Tight Special Flange



Explosion-Proof Torque Motor with Brake



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NEW TORQUE BULLETIN-This bulletin outlines basic facts about Peerless torque motors and shows applications. It is available FREE. Write for it today.

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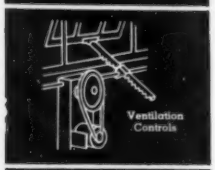

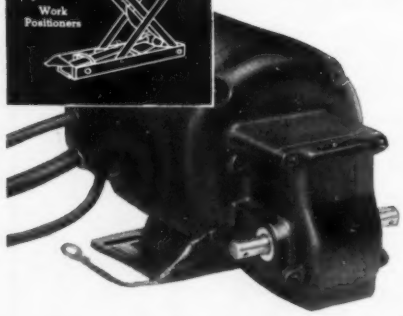

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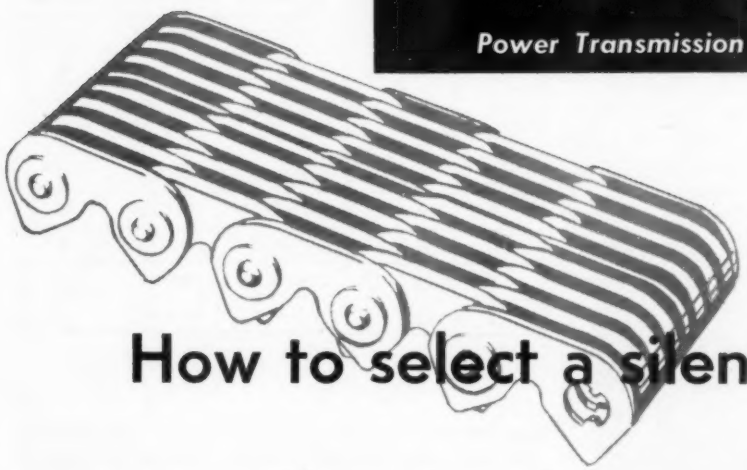
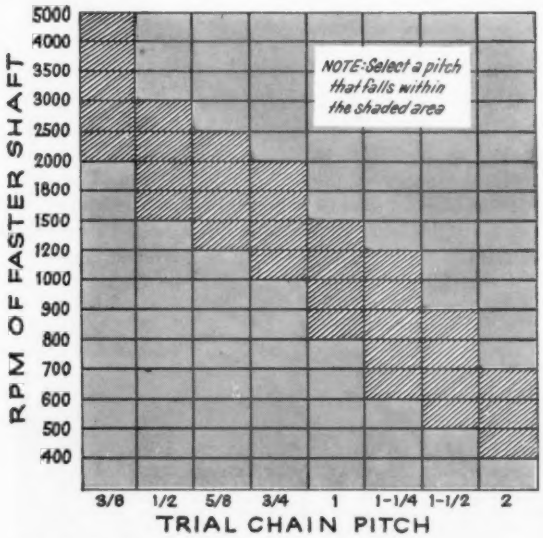


How to select a silent chain drive

Load Classification	Type of Load	Service Factors 10 hr day	24 hr day
A	Uniform	1.0	1.3
B	Moderate Shock	1.4	1.7
C	Heavy Shock	1.7	2.0

SELECT LOAD CLASSIFICATION and service factor here.



SELECT CHAIN PITCH from this chart.

***THIS ARTICLE** is adapted from the new Design Manual, Roller and Silent Chain Drives, prepared for the Association of Roller and Silent Chain Manufacturers, by Jackson and Moreland.*

SILENT CHAIN consists of a series of toothed link plates joined together to permit articulation. When the chain wraps around the sprocket, the links engage both sides of the sprocket teeth simultaneously.

Silent chains are designated by a combined letter number symbol. For example, SC302 means a silent chain of $\frac{3}{8}$ in. pitch, $\frac{1}{2}$ in. wide. The first one or two digits indicate the pitch in eighths of an inch; the last one or two digits indicate the chain width in quarter inches. Thus, SC1012 means a chain of 1-$\frac{1}{4}$ in pitch, 3 in. wide.

Problem

Let's select a silent chain drive to transmit 150 hp at 600 rpm from an electric motor to the countershaft of a rotary device at 150 rpm. The motor shaft is 4-$\frac{3}{4}$ in. dia. Shaft centers are approximately 60 in., but may be changed 2 in. either way. Operation is 10 hr/day.

Solution

Step 1: Select Load Type And Service Factor

The load type is listed as class B; the service factor as 1.4 from the table above.

Step 2: Select Design Horsepower

Multiply the specified horsepower by the service factor to obtain the design horsepower.

$$\text{design hp} = 150 \times 1.4 = 210 \text{ hp}$$

Step 3: Select Tentative Chain Pitch

Refer to the adjoining chart. Two possible chain pitches are best suited to the driver speed of 600 rpm. They are 1-$\frac{1}{2}$ in. and 2 in. pitch. The 1-$\frac{1}{4}$ in. pitch will also work. Since it is wisest to always use the smallest practical pitch, let's investigate the 1-$\frac{1}{4}$ and 1-$\frac{1}{2}$ in. pitches.

Continued on next page

Step 4: Select Final Chain and Smaller Sprocket

Refer to the table below. The smallest 1-¼ in. pitch sprocket that will accommodate the 4-¾ in. dia. motor shaft has 23 teeth; and nothing smaller than a 19 tooth sprocket can be used on a 1-½ in. sprocket.

For best operation, the small sprocket should range from 21 to 29 teeth. Let's investigate horsepower ratings at 600 rpm for:

1-¼ in. pitch; 23, 25, 27, and 29-tooth sprockets

1-½ in. pitch; 21, 23, 25, 27 and 29-tooth sprockets

Refer to a horsepower rating table, such as in the Design Manual of Roller and Silent Chain Drives, Machinery's Handbook, or any other reference book with silent chain data. From any of these tables, obtain the horsepower capacities per inch of silent chain width. To determine the width of chain that can transmit the design horsepower, divide 210 by the rating per inch of chain width for each selection. Your computations should also be shown on the table above in the next column.

Now review these selections, Selection F is 1½ in. pitch; the smallest pitch is always recommended and, in this case, is 1¼ in; the number of teeth in the small sprocket is closest to the minimum recommended and is within range of normal application; the small sprocket will accept the bore adequately; and the chain width is within 3% of the width calculated.

SELECT MAXIMUM SPROCKET bore from this chart.

Selection	Pitch	Teeth	Design hp ÷ by hp per inch	Required Chain Width	Width Available
A	1¼	23	210 ÷ 27	= 7.78	8″
B	1¼	25	210 ÷ 29	= 7.24	8″
C	1¼	27	210 ÷ 32	= 6.56	7″
D	1¼	29	210 ÷ 34	= 6.18	7″
E	1½	21	210 ÷ 32	= 6.56	7″
F	1½	23	210 ÷ 36	= 5.83	6″
G	1½	25	210 ÷ 40	= 5.25	6″
H	1½	27	210 ÷ 43	= 4.88	5″
I	1½	29	210 ÷ 47	= 4.47	5″

Step 5: Select Large Sprocket

Compute the number of teeth for the large sprocket using the selected small and specified shaft speed ratio. If the required speed ratio cannot be obtained with an integral number of teeth on the large sprocket, try a larger size for the small sprocket. Also check for clearance.

Since the driver shaft operates at 600 rpm and the driven at 150 rpm, speed ratio = 600/150 = 4.0. Therefore, the large sprocket will have 23 x 4 = 92 teeth.

Step 6: Compute Chain Length

Using the specified center distance, chain length can be computed by formula. Since the computed length might be fractional, a chain consisting of an integral number of pitches should be used. The next even number of pitches is preferable over an odd number since the latter requires an offset link. This would require that the center distance be corrected again.

Using 23 and 92 tooth sprockets on 60 in. centers

CHAIN PITCH	STANDARD WIDTHS																									
⅜	½	¾	1	1¼	1½	1¾	2	2¼	2½		3		4	5	6											
½	½	¾	1	1¼	1½	1¾	2	2¼	2½	2¾	3	3½	4	5	6		8									
⅝			1	1¼	1½	1¾	2		2½		3		4	5	6	7	8		10							
¾			1	1¼	1½		2		2½		3	3½	4	5	6	7	8	9	10	12						
1							2		2½		3		4	5	6	7	8	9	10	12	14	16				
1¼									2½		3		4	5	6	7	8	9	10	12	14	16	18	20		
1½											3		4	5	6	7	8	9	10	12	14	16	18	20	22	24
2													4	5	6	7	8		10	12	14	16	18	20	22	24	30

AFTER YOU KNOW chain pitch, select chain width from this chart.

(60 in. divided by 1-½ in. = 40 pitches), compute chain length as follows

$$L = 2C + \frac{N+n}{2} + \frac{(N-n)^2}{4\pi^2 C} \quad \text{.....(1)}$$

Where

L = chain length in pitches
C = shaft centers in pitches
N = number of teeth in large sprocket
n = number of teeth in small sprocket

Substituting values for C, N and n, we have

$$L = 2 \times 40 + \frac{92+23}{2} + \frac{(92-23)^2}{39.48 \times 40}$$

$$= 140.515 \text{ pitches}$$

Use 140 pitches.

Step 7: Correct Center Distance

Using the adopted length, recompute center distance. If the distance is fixed and the adopted chain length causes an objectionable slack, an idler should be used; or a sprocket combination that will provide a snug fit without objectionable slack.

Since the chain is to couple at an even number of pitches, use 140 pitches for L, and recompute the exact centers, in pitches

$$C = \frac{L - \frac{N+n}{2} + \sqrt{\left(L - \frac{N+n}{2}\right)^2 - 8\frac{(N-n)^2}{4\pi 2}}}{4}$$

$$= 140 - \frac{92+23}{2} + \sqrt{\left(140 - \frac{92+23}{2}\right)^2 - 8\frac{(92-23)^2}{39.48}}$$

$$= 39.73 \text{ pitches}$$

or 39.73 x 1½ = 59.60 in.

Conclusion

Since none of the other selections fitted the requirements as well, our final selection is 23 and 92 tooth sprockets mounted on 59.60 in. centers using 1-½ in. pitch, 6 in. wide chain.

By referring to the horsepower rating table (Design Manual of Roller and Silent Chain Drives, or Machinery's handbook), the recommended method of lubrication for 1-½ in. pitch chain can be provided by either a disc mounted adjacent to one of the sprockets, or by a circulating pump. If the shaft locations permit locating a sump in the drive housing, the disc method would be best.

Problem

Select a silent chain drive to meet the following conditions:

Source of power	**electric motor**
Transmitted horsepower	**30 hp**
Driven equipment	**mine fan**
Size of driver shaft	**2-⅛ in dia**
Speed of driver shaft	**1160 rpm**
Size of driven shaft	**2-⅞ in dia**
Speed of driven shaft	**400 rpm**
Approximate wheel centers	**22-¼ in**
Operation	**24 hr/day**
Space limitations	**none**

Solution

Load classification	**B**
Service factor	**1.7**
Design horsepower	**51.0**
Tentative chain pitch	**¾", 1", 1¼"**
Chain and small sprocket	

Selection	P	T	hp per in.	Width	Avail. Width
A	¾"	21	16	3.19	4
B	¾"	23	18	2.83	3
C	¾"	25	20	2.55	2½
D	1"	21	25	2.04	2
E	1"	23	28	1.82	2
F	1"	25	31	1.65	2
G	1¼"	21	33	1.55	2½
H	1¼"	23	37	1.38	2½
I	1¼"	25	42	1.21	2½

Select B, C, or D

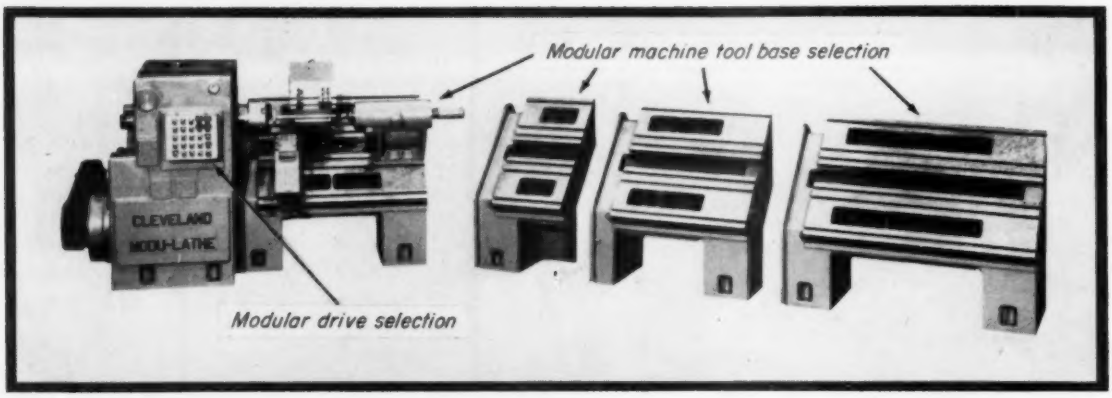
Speed ratio 2.9

Large sprocket	Small	Large	Use
	21	60.9	61
	23	66.7	67
	25	72.5	73

Driven shaft speed	Sprockets	rpm
	21 & 61	399
	23 & 67	398
	25 & 73	397

Used 1" P on 21 & 61T

Tentative center distance	
Inches	**22.25**
Pitches	**22.25**
Chain length	
Pitches—Computed	**87.32**
Used	**88**
Feet & Inches	**7'-4"**
Corrected center distance	
Pitches	**22.60**
Inches	**22.60**
Lubrication	**Disc**



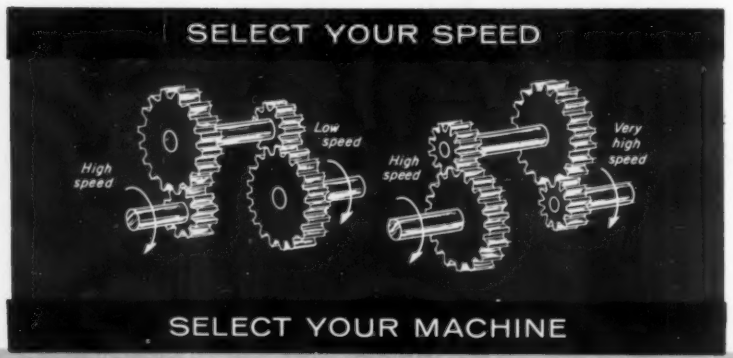
Interchangeable drives for modular machines

BY KENNETH ANTHONY, *chief engineer, Cleveland Hobbing and Machine Co.*

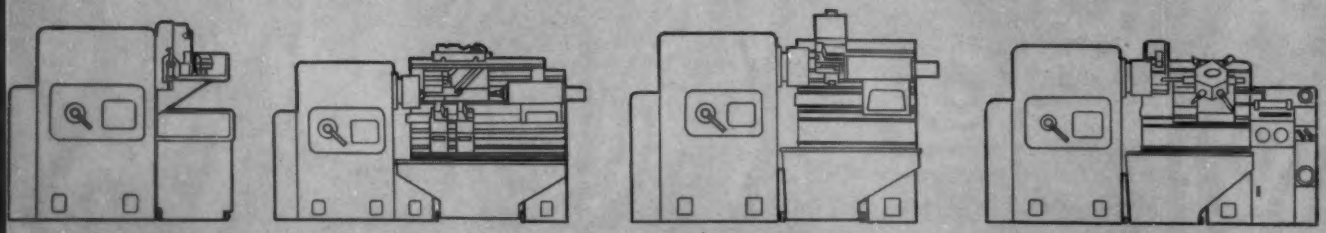
A BUILDING BLOCK CONCEPT is used in a new line of modular machines. Most any turning-type machine tool can be created from basic frame and various drive components. Turret lathes, pedestal duckers, bar lathes, stub profilers, face profilers and other machines can be assembled to have any speed range from 40 to 5000 rpm.

The object is low first cost plus wide selection and inexpensive changeover.

Interchangeable drive components include electric clutches, change gears, pick-off gears, a-c or d-c straight or reversible motors, external variable speed transmissions and electric clutch-brakes. All parts are interchangeable with only one basic headstock shell.



DIFFERENT GEAR COMBINATIONS, beds and components give wide selection to produce any one of many machines.



Feature 1: basic headstock accepts all gear combinations

BASIC HEADSTOCK SHELL and gearbox housing is the same for all machines. It can be equipped with up to six drive shafts each performing several different functions depending on the end machine operation. The headstock shell is heavily constructed with up to 2 in. thick high tensile cast iron walls and ribs.

The entire headstock is supplied with internal forced feed lubrication. The spindle shaft is dynamically balanced and mounted in precision anti-friction bearings available in speeds up to 5000 rpm.

The main driving shaft is powered directly from the motor through a V-belt drive. The machine can be fitted with or without a combination electric clutch-brake mounted externally; (or two internal electric clutches that supply the first range speed selection, or both).

For production work, where many speed changes are not required, headstocks are usually furnished with three (3) shafts. The main shaft (#1) accepts the drive from the motor through V-belts and is geared to a counter-shaft with pick-off gears that are easily and quickly changed for required spindle speed. This counter-shaft, in turn, is connected to the spindle by a high velocity, silent chain. In its simplest form the headstock can be furnished without clutch-brake if stopping and starting of the motor is not objectionable. In these cases the machine is braked by "plugging" the motor electrically. Where stopping and starting without shutting off the motor is a requirement, the machine is furnished with an automatic electric clutch-brake actuated by the main machine control. Where many speed changes are required, as in the case of turret lathes, a "Modular" pre-assembled speed change component, consisting of three shafts, electric clutches for automatic shifting, manual shifting handles, and gearing, fits into the face of the headstock and engages gears on the main shaft to transmit power through this assembly to the countershaft and thence to the spindle. This assembly provides up to 16 speed changes. It may be furnished with the machine or added later.

As an example, for a production lathe, a standard 1800 rpm motor could be used or a two-speed motor for 1800/900 speed reduction. A combination clutch-brake could be used on the external part of the main driving shaft to engage or disengage the main spindle from the motor. This lets the motor run at speed at all times without stopping. Without the clutch-brake, the motor is stopped by "plugging" after each cycle.

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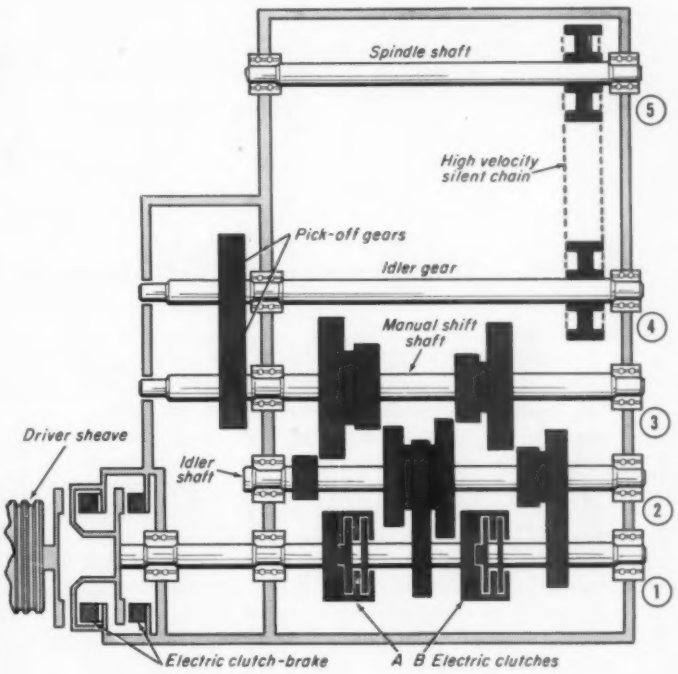
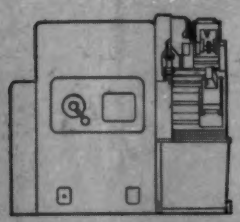
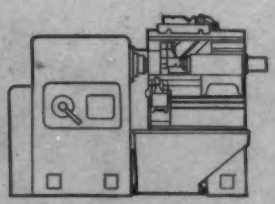


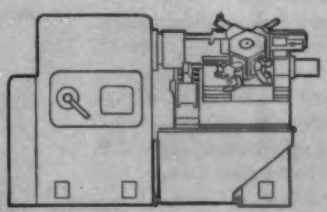
SAME HEADSTOCK SHELL is used for all machines. Combination of gears, clutches, clutch-brakes, motors, etc., produces wide speed range.



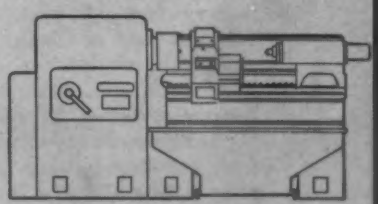
PEDESTAL LATHE



STUB PROFILER



AUTOMATIC CHUCKER



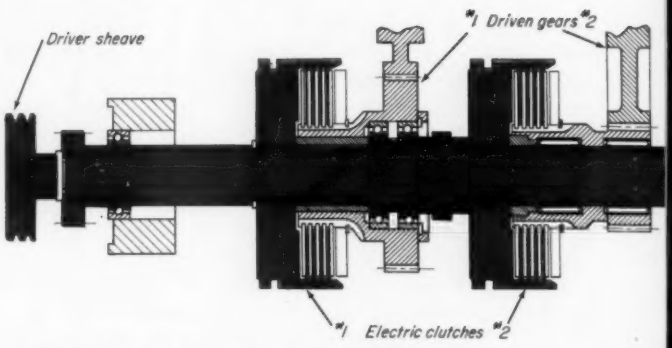
THREADING LATHE

Feature 2: electric clutches make speed changes automatic

TWO ELECTRIC CLUTCHES can be used for speed selection up to 5000 rpm (spindle speed). A mechanical shifter can be applied to give 4 speed selections by manual control. Pick-off gears can be used to change range for any given ratio. Two electric clutches can be applied to the main driving shaft to give the machine two additional speed ranges—and automatic selection.

The clutches do not move gears in and out of mesh, but engage or disengage friction discs inside the clutch housings to select the gear desired. Clutch 1 on the left gives 38/62 speed increase; clutch 2 gives 30/70 increase.

The clutches have splines on their ID journals for coupling to the splined headstock shaft. The stationary and rotating members are clutched or declutched on electrical signal from the main automatic control.



TWO ELECTRIC CLUTCHES on main drive shaft provide automatic, silent speed change.

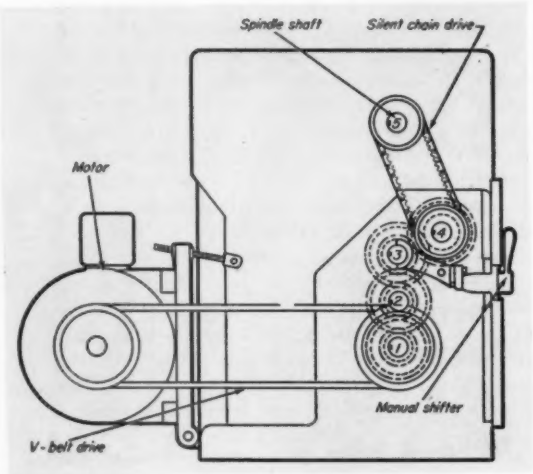
Feature 3: high velocity chain permits high rpms

A HIGH VELOCITY SILENT CHAIN drive is used to power the spindle shaft between shafts 4 and 5 in the headstock. The chain drive is used for several reasons. One is because of the high speed requirements of the spindle shaft. Since the shaft is mounted in extra heavy precision bearings its center distance from shaft 4 is large. The chain is therefore used instead of gears which would require large pitch diameters and be extremely high precision for 5000 rpm operation. In addition, gears engage at a few teeth as compared to complete wrap around of both sprockets by the chain. Greater power is therefore realized, by the use of chain.

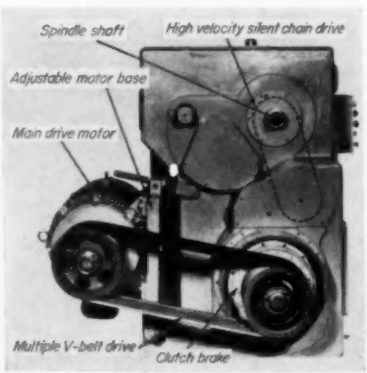
The headstock with its force-feed lubrication keeps the chain constantly lubricated. The sprocket has an involute tooth form which conveys power smoothly to the spindle shaft without jerkiness or vibration. The chain operates with very high loads, and velocities without appreciable wear.

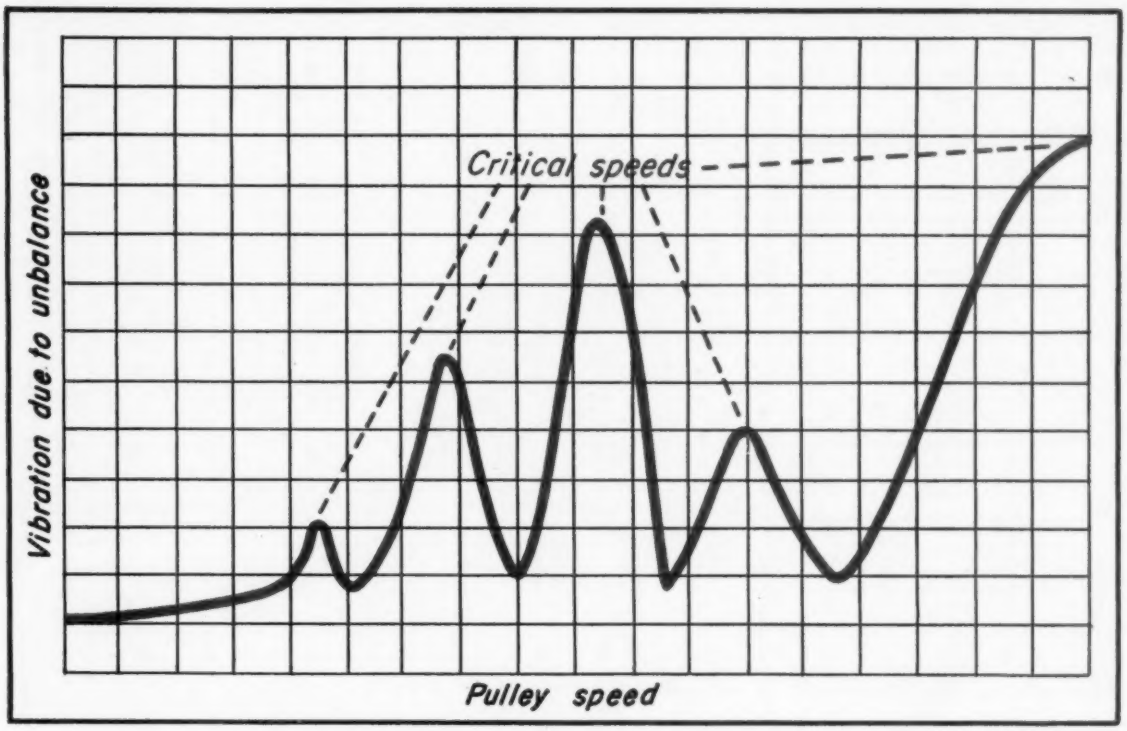
The headstock interior is easily accessible by removing sideplates to give access to the gear box cavity.

The building block concept of the machine and drive components permit many different kinds of customers to buy only what they need when they need it. They can add or change any component as needs change. One of the chief features of the design is low first cost of any given machine, different as it may be from any other. Drive components can be selected like tooling and can be written-off in some cases. The drive parts are made in production quantities free of custom-built costs inherent in other types of machines. Whole machines can be rebuilt or changed over with new factory parts.



HIGH VELOCITY silent chain operates on sprockets with tooth form.





VIBRATION CURVE shows different critical speeds caused by unbalanced parts. All machines have critical speeds.

How to cope with critical speeds

By WILLIAM A. WILLIAMS, *consulting editor*

AN UNSEEN SOURCE of destruction in high-speed drive equipment is unbalance. Its presence is indicated by vibration.

How much vibration is tolerable, and to what extent it shortens life of bearings, shafting, gears, chain, belts, and other components varies.

There is no simple answer to, "How much is too much?" Experience indicates that, "When it is bad enough to be noticeable, its too much."

How To Cope With It

For those of you who have a portable field vibration analyzer, the magnitude and probable source of vibration can be detected quite easily. You can also use the analyzer to help re-balance the offending rotating parts right on the job. If you don't have such equipment, you can try good guesses and remove the pulley, sheave, gear or sprocket you suspect—and have it balanced. Your balancing specialist will want to know how "close" you want it balanced. If you don't know, leave it up to him.

The reason for so much lack of knowledge about balancing is because vibration characteristics of different machines are never the same; what works for one may not work for another.

Critical Speeds

Every machine has a number of critical speeds, which are specific speeds at which rotating parts vibrate because of inherent unbalance. It's inescapable on all machinery but, when it exists above or below operation speeds, will cause little harm. Gears and pulleys are like a bunch of tuning forks, each one responding to a different frequency of excitation. If your machine happens to be running at one of these speeds, it will vibrate more than at 10 or 20 percent above or below the speed.

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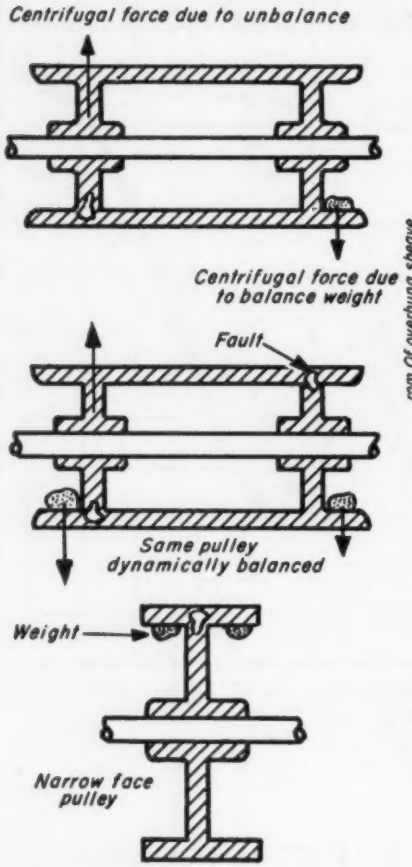

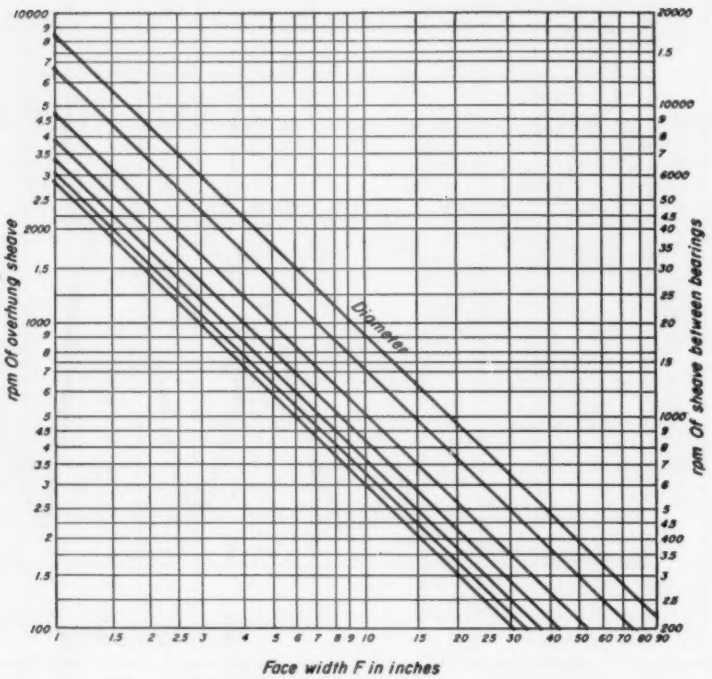

UNBALANCE CAUSES CRITICAL SPEEDS. Parts (left) have uneven mass or void areas. Weights are applied to external surfaces to bring parts into static and dynamic balance. Curve shows when balancing is required.

Power transmission manufacturers cannot guarantee that standard balancing of their products will prevent your machine from vibrating. The amount of vibration caused by a given amount of unbalance for any given component can vary by 10 to 20/1 depending on the nature of the machine it is mounted on.

Static Balancing

Static unbalance can be detected by mounting a pulley or rotor on a shaft in sensitive bearings. The heavy side will go to the bottom. Static balancing consists simply of placing weights on the side opposite the heavy side, so that the pulley will have no heavy side and be "in balance."

There is an unfortunate misconception that if the location and amount of static unbalance is determined during rotation, better balancing can be done than if the pulley is not rotating. This isn't so for static balancing.

The drawings show a wide-face double-arm pulley with a blow-hole at the junction of the arm with the face. This is the most common place for faults to occur. When statically balanced, you have no way of knowing where to put the balance weight along the pulley width. If you put it opposite the blowhole, you may still have severe dynamic unbalance when you get it back to speed. This, of course, will be evidenced through continued vibration, even though the pulley is perfectly balanced statically.

Dynamic Balancing

Dynamic balancing corrects the unbalance of each end of the pulley independently of the other. This always requires special equipment.

Dynamic balancing requires that fixed weights be judiciously placed on the pulley as decided while the pulley is rotating. This type of balancing can also be done by grinding off or removing material from the heavy side instead of adding to the light side.

If a pulley has a void, single balance weight on one side might cause some dynamic balance; but two weights, one on either side of the arm width would more readily correct dynamic as well as static balance. Manufacturers know this and place correcting weights on both sides of the rim to achieve this even though only static balance is called for. Even when unbalance is not caused by a blow hole or void, it can be caused by thickness variations in arms or webs, and is therefore most often located axially to that plane.

When To Dynamic Balance

How and when do you specify dynamic balance

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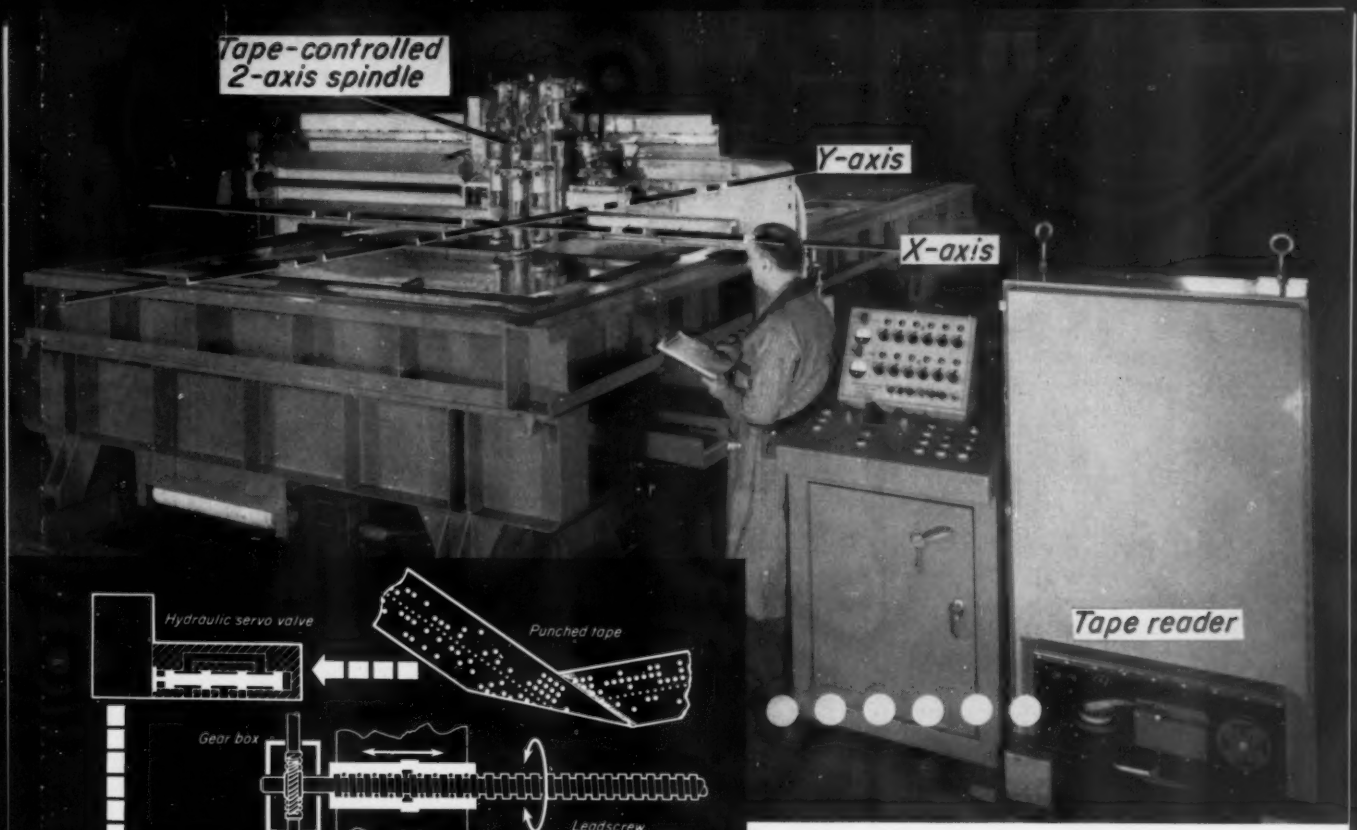

SHAFT POSITION is controlled by punched tape. Tape signals operate hydraulic valves that vent oil to hydraulic motors that turn shafts. Shafts are precision ball-nut leadscrews along which carriage and gantry advance.

How to control shaft position

. . . with punched tape

BY CY MILLER and L. E. JOHNSON, *The McKay Machine Co.*

SHAFT POSITION is controlled by punched tape in a new two-axis drilling machine. The machine is used to position welding heads or drill holes in the 3/8-in. aluminum surface skin of a 2000-mph aircraft wing during construction.

Tape signals move the drill spindles crosswise along an X-axis; and lengthwise along a Y-axis. Final position within 0.0001 in. can be attained along each axis with the tape signals without manual aid. Here's how it works:

The tape system consists of a tape reader and decoder; stepping switch assembly; power supply and amplifier; resolver and glass scale units; servo amplifiers and hydraulic motors.

The tape generates signals that pass through the system as final error signals. The error signals cause the hydraulic motors to rotate and advance the spindle carrier and gantry in directions that will reduce the error signals to zero. A resolver on each motor feeds back coarse and medium error signals. A glass scale along each axis feeds back final, minute error signals. These signals drop to zero when the spindles arrive at final position called for by the tape. This stops the hydraulic motors.

Manual operation is also made possible by manipulation of dials on the control console. The machine operator can dial the actual decimaled numbers directly to produce the same electrical signals supplied to the stepping switches from the tape reader and decoder.

The welded steel drill carriage moves on a center V-way lined with edged-grain Formica. Four rollers attached to the carriage oppose the V-way to keep the carriage in alignment.

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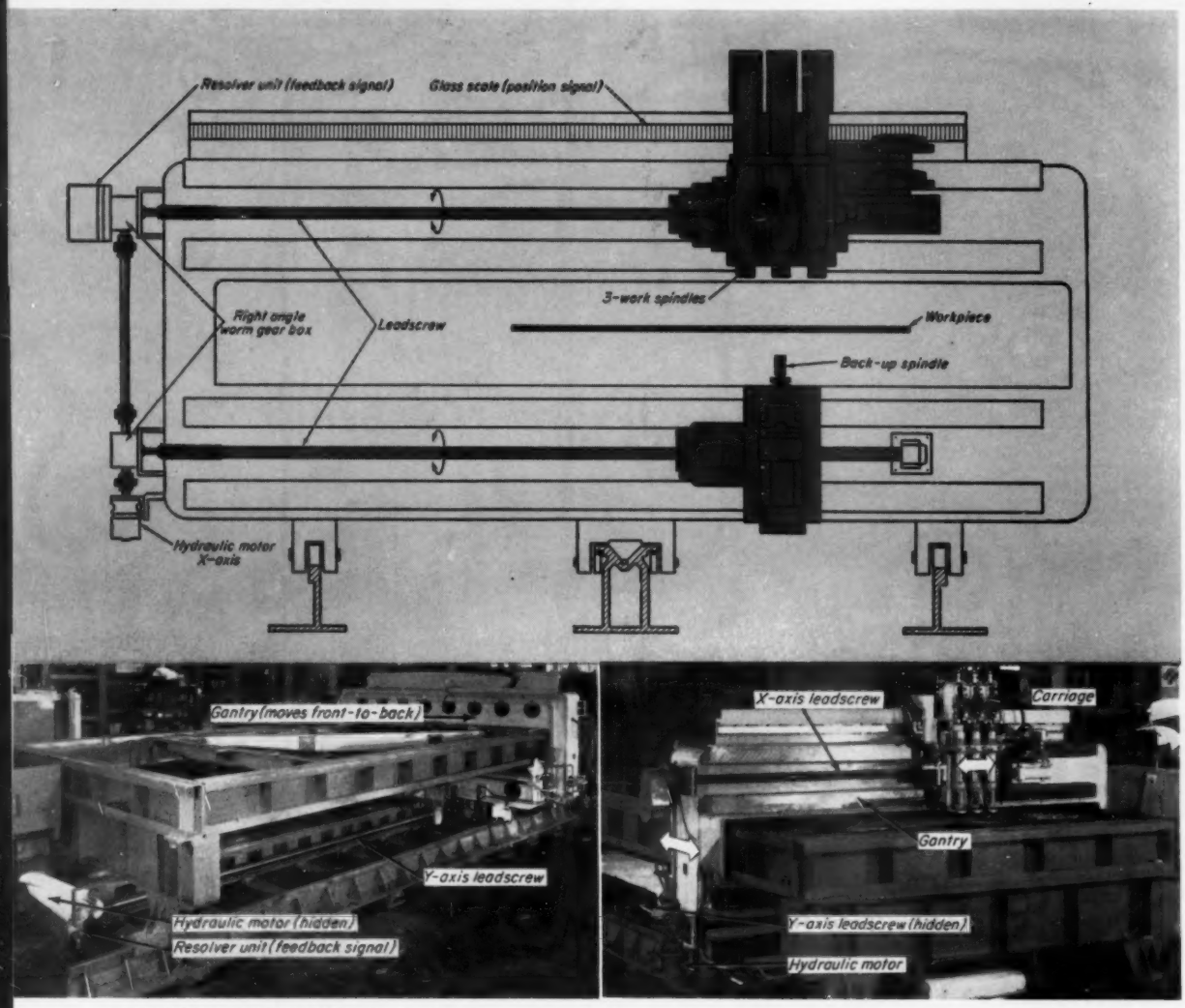


ON SIGNAL FROM TAPE, hydraulic motors turn leadscrews in one direction or other. Motors turn until error signals fedback by resolvers and glass scales are reduced to zero. Each motor gets independent signal.

Feature 1: hydraulic motors power precision ball screws

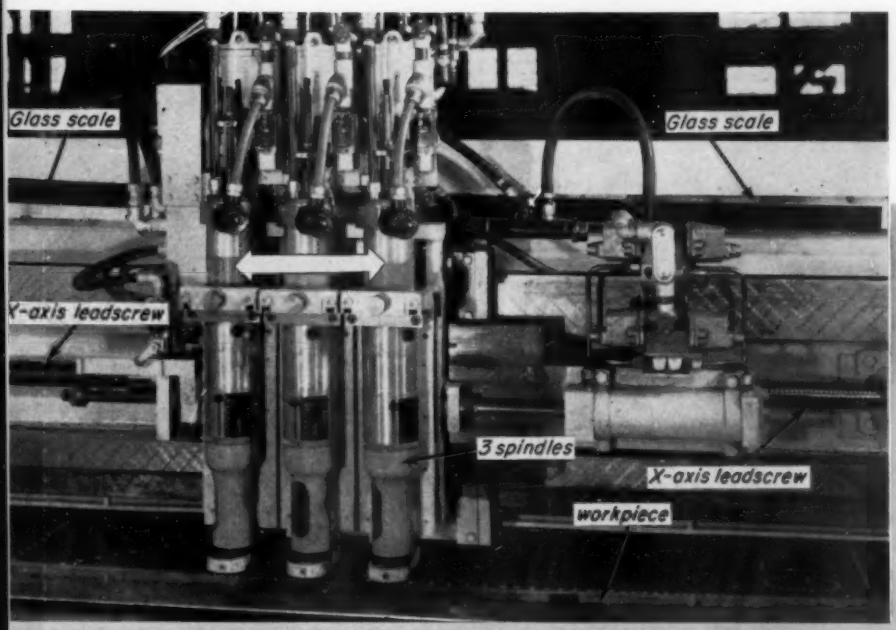
Two hydraulic motors do all the two-axis positioning. The larger motor moves the heavy gantry lengthwise along a precision leadscrew located at bottom-center of the machine. The smaller motor moves the spindle carrier from side to side on two leadscrews (above), all locations having X and Y identification.

The motors receive their commands to operate by receiving hydraulic fluid under pressure from their respective servo valves. The servo valves are 2-stage, forced-feedback. They control the direction and volume of flow to the motors. Action can only be instituted by electrical error signals stating that the spindles are not at final location. Thus, the motors turn as long as there are error signals.

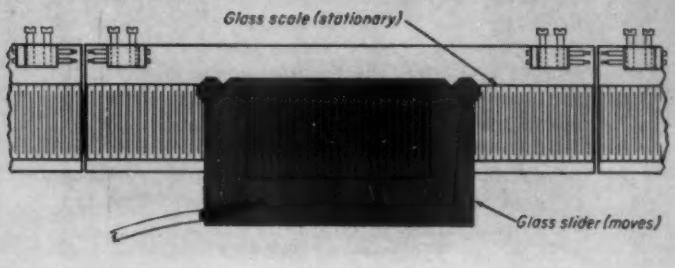
When the error signals approach and reach zero, the solenoid valves close accordingly and cut off flow to the motors. The system always has absolutely no tendency to dither—a tendency to hunt a very small amount over point zero—to correct and eliminate the last trace of error. It rests firmly at point zero.

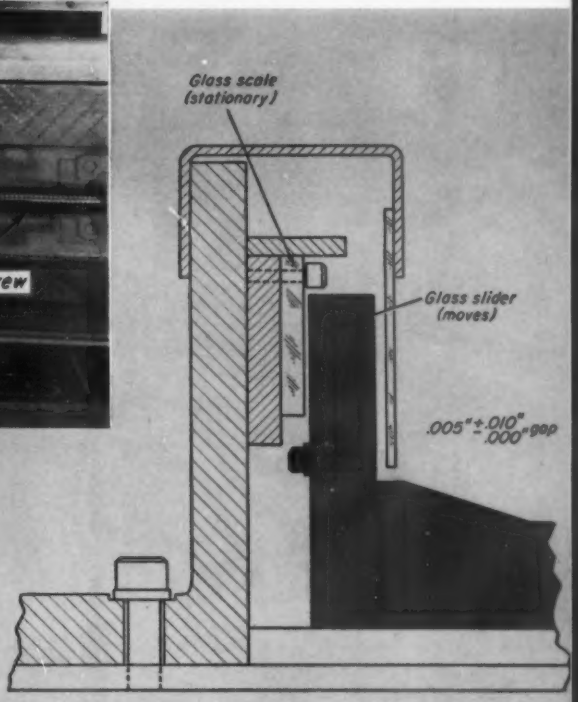
The motors turn precision ball nuts and screws. Coarse and medium error signals cause the motor to rotate faster than fine error signals that cut in just prior to arriving at final position.

The motors operate to: reduce the coarse error to less than 3 in.; reduce the medium error to less than 0.03 in.; reduce the fine channel error to zero. The coarse and medium error signals are generated by resolvers mounted adjacent to the motors. The fine error signals are generated by scales.



SPINDLE POSITION, within 0.0001 in. true, is located by glass scale which is a type of printed circuit. The scale is a long length of small sections mounted side by side.





Feature 2: glass scale locates final position within 0.0001 in.

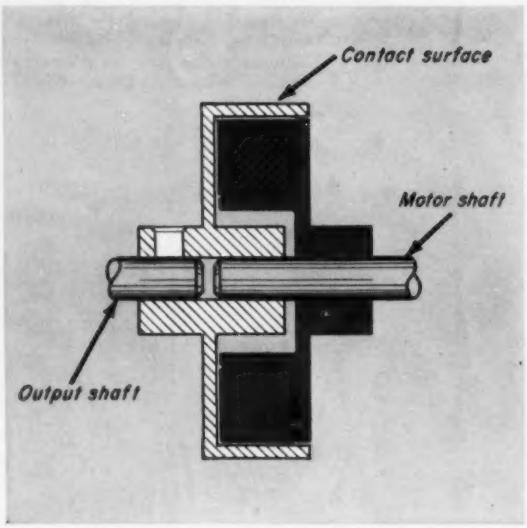
Final shaft position for each axis is decided by a long glass scale consisting of individual short sections mounted side by side to form an endless printed circuit. The scale for each axis is independent of the other.

A glass slider moves along each scale and resolves the final 0.03 in. of shaft position error. Thus, as the gantry is advanced along its leadscrew, the slider moves along the scale and translates position into voltage with respect to a zero reference point. Similarly, the slider on the carriage moves along its scale to send back its actual position. Without these signals the control system wouldn't know how far the hydraulic motors rotate when advancing the spindles.

There are three different degrees of error signals: coarse; medium; and fine. The coarse and medium signals are generated and fed back by resolvers mounted adjacent to the motors. The resolvers are synchros that send out sine and cosine signals of shaft angle position with respect to the stator. If a motor rotates and advances the carriage 40 inches along its leadscrew, the resolver sends voltage signals proportional to that distance. The fine signals are generated and fed back by the glass scales which are very sensitive to minute change in position.

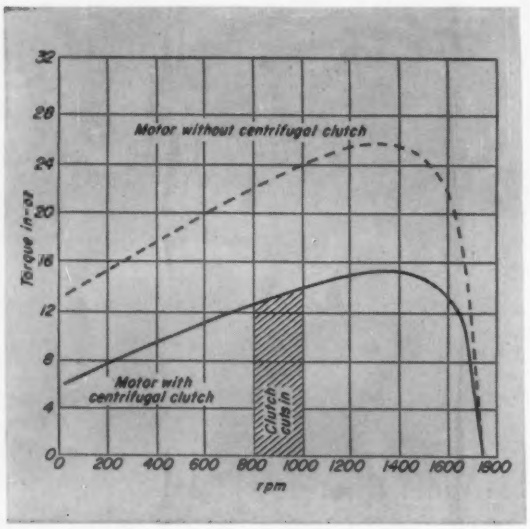
Coarse signals cover dimensions from 0-200 inches of movement, in steps of one inch increments; these are the most inaccurate of the three, requiring plus or minus 0.4 in. to function well. Medium signals cover dimensions of 0 to 10 inches and require plus or minus 0.005 in. to function. Fine signals cover dimensions of 0 to 0.1 inches in steps of 0.0001 in. These are the most accurate of the three having a tolerance of plus or minus 0.0001 in. per ft of travel.

All control signals are fed directly to the transducer resolvers so that error signals can be produced to return the machine to correct position. These signals cause the motors to rotate in the direction necessary to reduce the signals to zero. The tape can be punched in the production or engineering offices.



Increase starting torque with centrifugal clutches

by **RUSSELL NADHERNY,**
consulting engineer



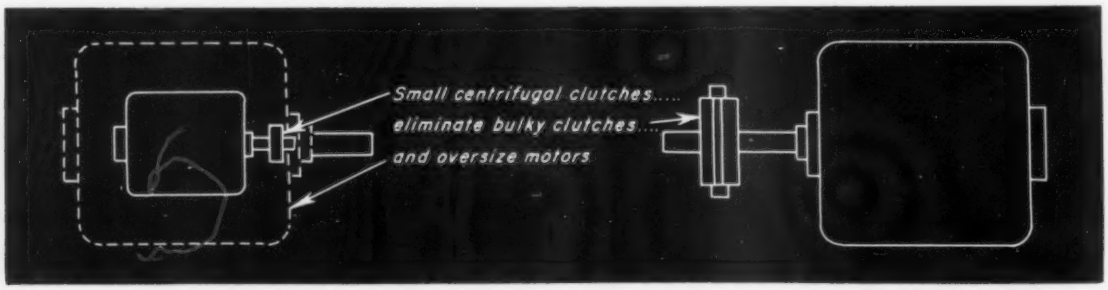
CENTRIFUGAL CLUTCHES are small and are used on motor shafts to increase starting torque. Curves show when motor picks up load during acceleration. Rotor has more energy to accelerate load at this point than at dead stop. Clutches are simple devices with friction faces that engage due to centrifugal force of the rotating driver.

YOU CAN ELIMINATE oversize motors and increase the starting torque with centrifugal clutches. Centrifugal clutches are small and are produced in many shapes and sizes, spring loaded or magnetic, shoe or disc, etc. They mount on the motor shaft, cut in and out at fixed speeds to connect the driving and driven shafts. They let motors come nearly up to speed, free of starting load, before cutting in. They reduce shock, provide overload protection, eliminate the need of larger controlled-type clutches. They can cut starting current by 60% to 70%.

There are a number of different makes of centrifugal clutches. Usually no more than 3 or 4 moving parts are involved. They are designed to cut in when the motor reaches approximately ¾ full-load speed. At this point, the clutch couples the driving and driven shafts. The motor picks up the load and continues accelerating to rated speed but with considerably less effort than from a dead start. Let's solve a typical problem by designing and applying a centrifugal clutch.

Problem

Provide a drive for a machine where noise must be restricted. The machine has a 12 in-oz starting torque.



Solution

Select a small shaded-pole motor weighing about 5 lbs with 6 in-oz starting torque and a centrifugal clutch. The clutch is to cut in between 800 and 1000 rpm. Motor speed will continue to increase until the torque requirements equal the corresponding characteristics shown at point A on the curve. This would be at about 1650 rpm for the 12 in-oz of torque.

Without a centrifugal clutch, the shaded pole motor would have to be twice as heavy, considerably larger; and the difference in cost would be greater than that represented by the smaller motor and clutch.

The clutch to meet these requirements could be developed from two simple die castings with two floating shoes. Clutch action is based on the centrifugal force created by rotating a friction component inside a confining surface.

The resulting torque is the tangential component of centrifugal force multiplied by coefficient of friction between the two surfaces. The internal element connected to the motor shaft carries the loosely held shoes. The external elements, although centered on the motor shaft, connect to the output shaft and restrain the shoes.

The equations for the clutch are therefore

$$F = \frac{mV^2}{r} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

and

$$T = F x \theta x R \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

where

F = centrifugal force
m = mass
r = radius of C. G. of shoes
R = radius of friction surface
T = torque
V = velocity
W = weight of shoes
θ = coefficient of friction

If we let $R = 1$ in, $W = 2$ oz, $r = 3/4$ in, $\theta = 0.3$, rpm $= 1000$, then

$$F = \frac{2}{32.2} \times \frac{\left(3/4 \times 1/12 \times 2 \times \frac{1000}{60} \right)^2}{3/4 \times 1/12} = 43 \text{ oz}$$

$$T = 43 \times 0.3 \times 1 = 12.7 \text{ in-oz}$$

The two-shoe arrangement of this clutch balances out effects of gravity in the force equation.

The clutch is able to develop 12.7 in.-oz torque at 1000 rpm, and thus would satisfy the condition of developing 12 in-oz torque between 800 and 1000 rpm.

This clutch is one of the simplest type, inexpensive and foolproof; however, for other conditions, clutches can be developed with self-energizing shoes after reaching a predetermined tangential force.

Spring-loaded mechanical elements can be included which, at a predetermined speed, can engage a pawl and ratchet, thus mechanically inter-locking the driving and driven members. The choice depends on the application and results desired.

BOOKS

ASTM Standards on Petroleum Products and Lubricants

Published by the American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pennsylvania; Supersedes December '57 edition; Price $8.25.

Brings together 187 standards, 57 of which have been revised, had status changed, or are new to this edition. Some of the topics covered are: Lubricating Oils, Industrial Oils, Turbine Oils, and Electrical Insulating oils.

The new edition brings together, in convenient form, the various ASTM standard and tenative methods of test specifications pertaining to Lubricants.

A Survey of Journal Bearing Literature

By Dudley D. Fuller. Published by the American Society of Lubrication Engineers, Chicago, Ill.; 260 pages; Price $15.00.

Contains approximately 2500 references with abstracts which cover the entire period, beginning with the earliest known literature on the subject. Years covered reach all the way up to 1954.

The purpose of the abstracts is to outline the scope and conclusions, together with the general significance of the material included in specific references.

In addition to the alphabetical listing, a review of outstanding or important literature is included, written on the basis of subject matter discussed. This gives an objective view concerning journal bearing analysis, design, performance, and maintenance.

The importance of this work cannot be overestimated. Tracing the history of journal bearing literature from its first recorded writing to the present time offers a rich background of ideas and comparison for the power transmission designer and engineer.

It should be included in most technical and engineering libraries and should be available to most persons whose positions require that they be well informed on the subject of journal bearings.

A Vibration Manual for Engineers

By R. T. McGoldrick, David Taylor Model Basin, U. S. Navy; available from the Office of Technical Services, U. S. Department of Commerce, Washington 25, D. C.; listed as Manual PB 131785. *Second Edition; Price:* $1.00.

This 32-page manual contains formulas useful to design engineers in minimizing trouble with mechanical vibration. Formulas used for vibration calculations by engineers in the Structural Mechanics Division of the David Taylor Model Basin are illustrated and explained. The book is a revision of an edition published in 1944.

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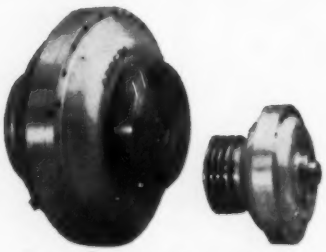
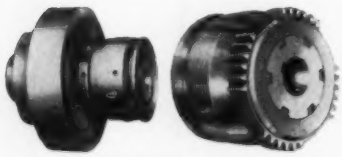
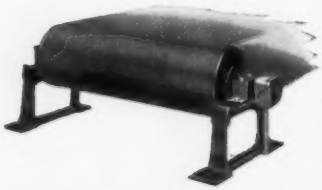


Hydraulic couplings and drives, for smooth, stallproof transmission.



Disc-type friction clutches for industrial and machine tool application.



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Rocking chain drive regulates cloth tension

A ROLLER CHAIN DRIVE rocks back and forth to help regulate cloth tension in a cloth desizing steamer. The chain and sprockets transmit the rocking motion to several rheostat controls which adjust speeds of the roll-drive motors, to maintain tension on the cloth web travelling through the machine at a nearly constant value of 10 to 15 lb.

The cloth is driven at 120 to 130 yards/min by four dc motors powering feed rolls outside the steam housing and three driver rolls inside the housing. In addition to the drive rolls there are idler and dancer rolls to guide the cloth and sense tension. Dancer rolls are mounted entirely within the housing on arms fastened to rocking shafts. Another arm fastened to the rocking shaft outside the housing has a counterweight hung from it to counterbalance the dancer roll. Amount of weight used determines cloth tension.

If cloth tension varies from the required value, the dancer roll moves either up or down; down for increased tension, up for low tension. As the dancer roll moves, it rotates the rocker shaft. This rotation is transmitted by a sprocket keyed to the end of the rocker shaft and roller chain to a sprocket on the rheostat shaft. The rotation of the rheostat adjusts speed of the appropriate drive motor to maintain proper tension.

In the desizer shown, there are four drive motors and five speed-adjusting rheostats. One of the rheostats adjusts speed of the drive motor at a station ahead of the desizer.

Drive motors are mounted on platforms at the side of the machine and drive through inline speed reducers.

This is an unusual application of the chain and sprocket principle to solve a problem in power transmission under circumstances involving control and constant regulation of tension.

As the cloth tension changes while the cloth is undergoing steaming and desizing, these unpredictable variations are sensed and transmitted so as to correct the tension-variation.

By applying the power transmission characteristics of the chain and sprocket, the engineer was able to develop his idea-application as a solution.

This system and the machine are made, and patents are held, by *Cook Machine Co., Subsidiary Riggs & Lombard Inc.*, Lowell, Mass.

ROLLER CHAIN AND SPROCKETS feed back dancer roll motion to maintain constant cloth tension.

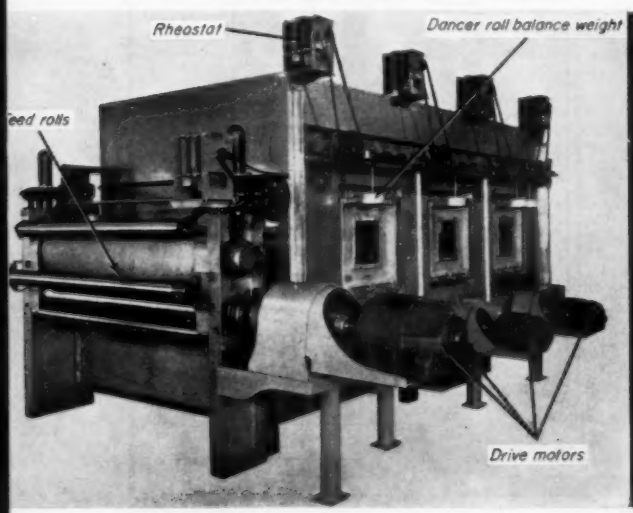
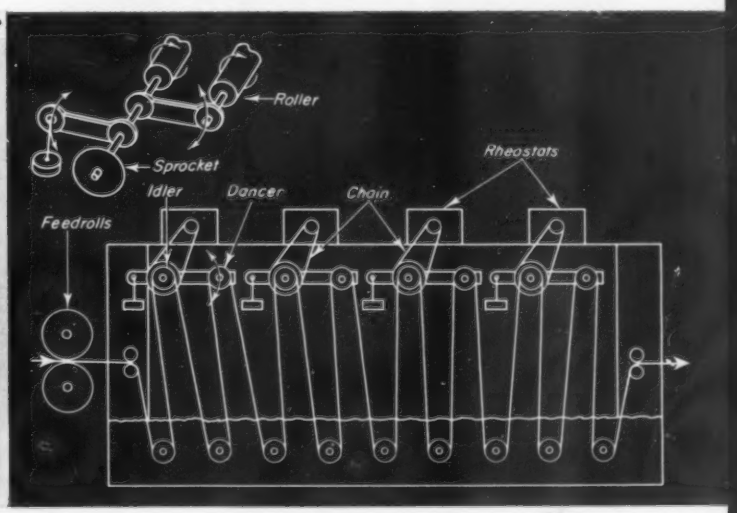


DIAGRAM of roll arrangement and feedback system using chain and sprockets.



Friction-drive provides completely

FRICTION-DRIVEN PINION gives economically variable speed to a winding machine used in a textile plant.

A foot-pedal operated plunger presses against a spring, forcing a large friction-wheel into contact with the pinion, giving the operator control over his machine's speed at all times. The motor runs continuously.

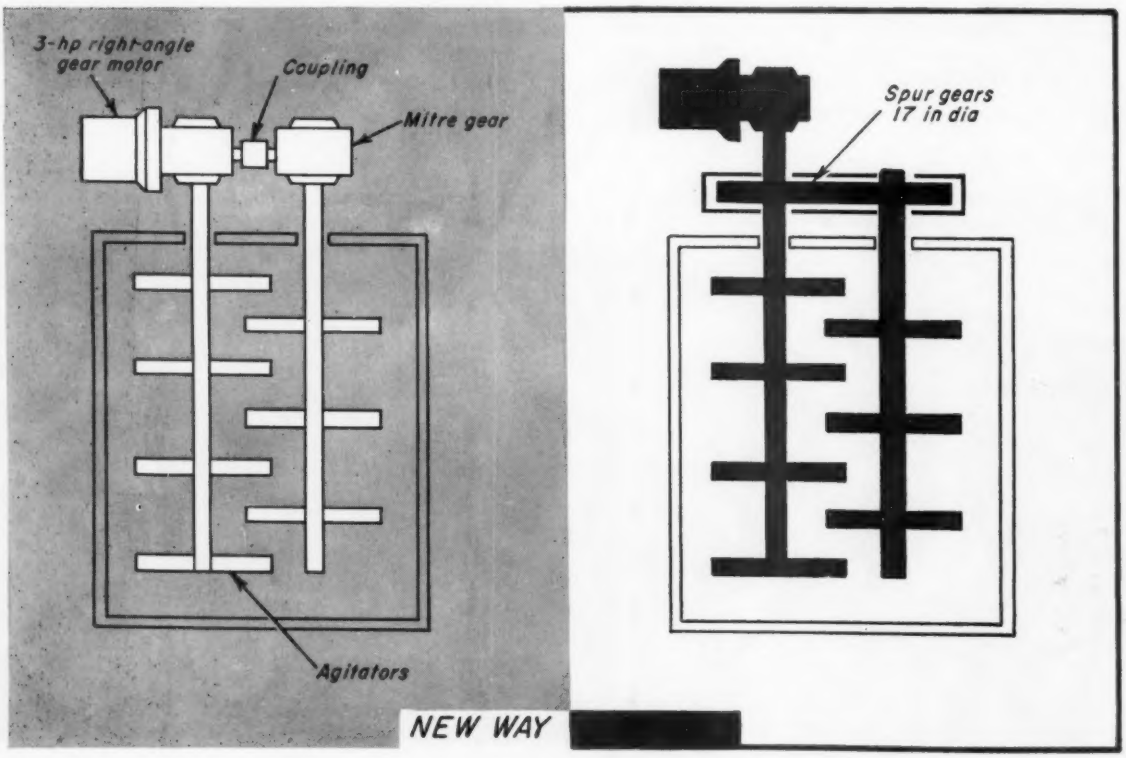
Formerly, a start-stop motor was used. This had several disadvantages. First, control of speed variation was difficult and limited the machine's usefullness. Second, the motor and its drive filled up needed space in the operating area of the machine. There was not enough room for the motor and its attached speed reducer in this area.

Third, and most important thing, there was an overheating problem. The start-stop action was too frequent to allow the motor to attain sufficient speed for the temperature drop-off needed for efficient, maintenance-free operation.

Solution to this problem was found when the friction drive was installed. Motor used is a 2-hp, 3 phase, 220 volt, 1760 rpm. The spring gives a quarter-inch slide for a clutching action. This gives the operator constant start-stop control over his machine and eliminates the need for the on-off switch formerly used. The large friction wheel has a 1 : 6 ratio with the motor-driven

Enclosed gearing eliminates

GEARMOTOR KEEPS MILK CLEANER in unit seen at left. The *new way* uses a mitre box to power the second agitator. *Old way*, at right, shows gear arrangement which has been replaced.

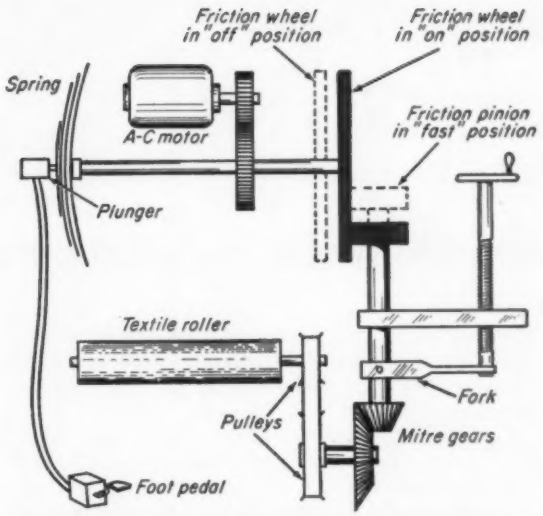


variable speed

pinion. A fork attached to a jack-screw moves the friction-pinion, giving speed control by lengthening or shortening the turning-diameter of the large wheel.

The pinion-shaft is held by a support which keeps it in place while the small friction wheel slides in a keyway along the shaft to make this speed variation possible. Power is transmitted through a miter gear, belts, and pulleys as shown at right, to rotate the winding shaft.

Friction drive described here is now working in the plant of the *Newburgh Moire Co., Inc.*, New York City.



FRICTION DRIVE with spring clutch gives variable speed control without over-heating or other problems.

sanitation problem in food industry

ENCLOSED RIGHT-ANGLE GEAR box solved a sanitation problem in a dairy.

Driven by a gearmotor with a right-angle gear drive, the gear drive is completely sealed so that leakage of oil or other lubricant-debris is minimized.

Previously, the agitator-blades were rotated by an electric motor coupled to a right-angle gear reducer. Lower end of the gear reducer's shaft powered one agitator paddle. Mounted above the paddles and below the gear reducer, a pair of spur gears, 17-inches in diameter, powered the second paddle.

The second gear was driven by the first, a lubrication-need was created, resulting in a potential nuisance of lubricant drippage. Partial correction was obtained when a stainless steel housing was installed, covering the gears. But leakage still occurred. This is, of course, undesirable in dairy work.

At present the agitator paddles are powered by a gearmotor, right-angle gear reducer, and flexible couplings.

Power source is a right-angle 3-hp, 60-cycle, 3-phase, 440 volt gearmotor. The output shaft has 24-rpm. This application eliminated the right-angle gear reducer formerly used. Driven directly by the right-angle output shaft is the left-hand mixer-agitator. A coupling ties the extension counter-shaft of the gearmotor to the newly-added right-angle gear box. This assured perfect alignment between gearmotor and gear box.

The right-angle gear box drives the right-hand agitator-shaft. By extending the center shaft, the motor is tied into the reduction unit.

Because gears in the gearmotor and right-angle gear box are remotely enclosed and sealed, there is little possibility of any lubricant escaping. The sanitation problem is solved. One-piece housing assures proper alignment of the internal gearing of the gearmotor.

Installation of the coupling and the gear box have eliminated the cost of maintaining the stainless housing, keeping it as leak-proof as possible, and checking its effectiveness.

At the present time this application is installed and functioning in dairy and food processing plants. It has solved a sanitation problem.

The use of couplings as a means of transmitting power from gearmotor to gear box means that no lubricant is needed in this area. Adapting gear motors to similar problems has potential, offering solutions to power transmission problems falling in this specific classification.

This application of these particular power transmission items was developed for *Lever Brothers Co.*, New York City.

Remote motor installation overcomes corrosion problem

SINGLE LINE SHAFT, mounted remotely from driving motor, transmits power to a corrosive-fume filled area—protecting the motor from damage in a shellac manufacturing plant.

By placing the motor far from shellac vats, maintenance costs were cut approximately 50% and efficiency doubled.

Choosing the motor site was the answer to the corrosion problem and it had to be done carefully. Clearance was needed for belts, pulleys and overhead shafting. The motor is 50-hp, 220-volt, a-c, 1200 rpm and is vapor proof to help prevent corrosion by fumes.

The motor turns a 6-inch pulley, driving a belt that turns a shaft-pulley three feet in diameter. As many as 15 mixing vats are agitated off one shaft.

A second 6-inch pulley drives a belt that turns another three-foot diameter shaft-pulley. This second shaft may also drive as many as fifteen agitators in mixing vats. Shafts are 50-feet long.

Corrosive fumes fill the atmosphere in the vat area. Agitators in each vat are driven by a vertical pulley two-and-one-half feet in diameter. These are powered by twisted two-inch belts.

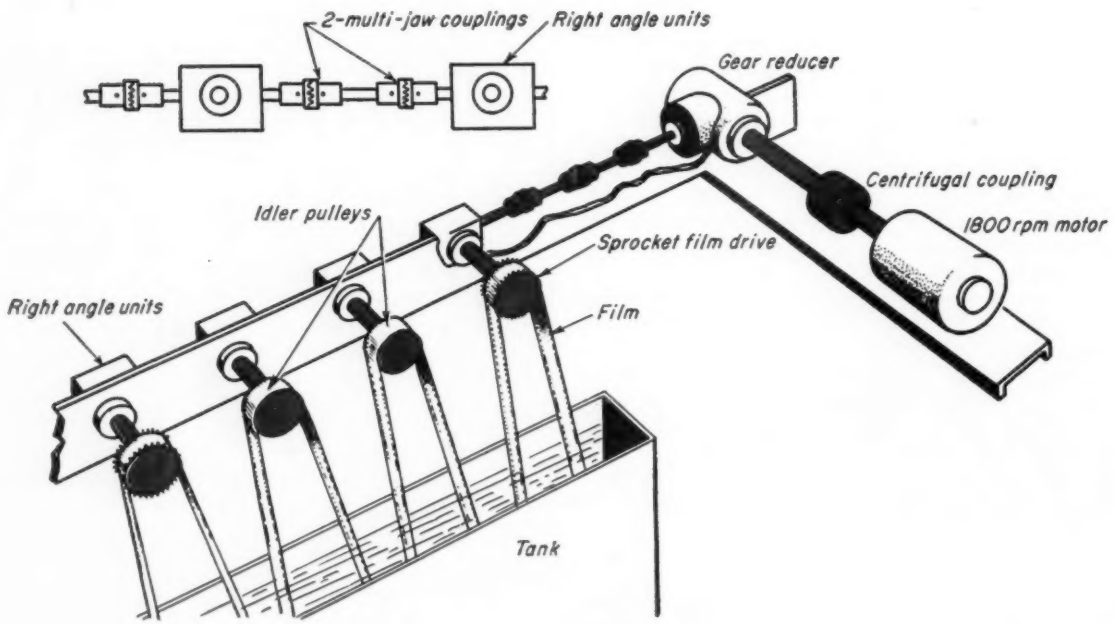
Vats measure 10-feet by 15-feet. Agitators turn at 15-rpm, because shellac must be stirred slowly for effective manufacture.

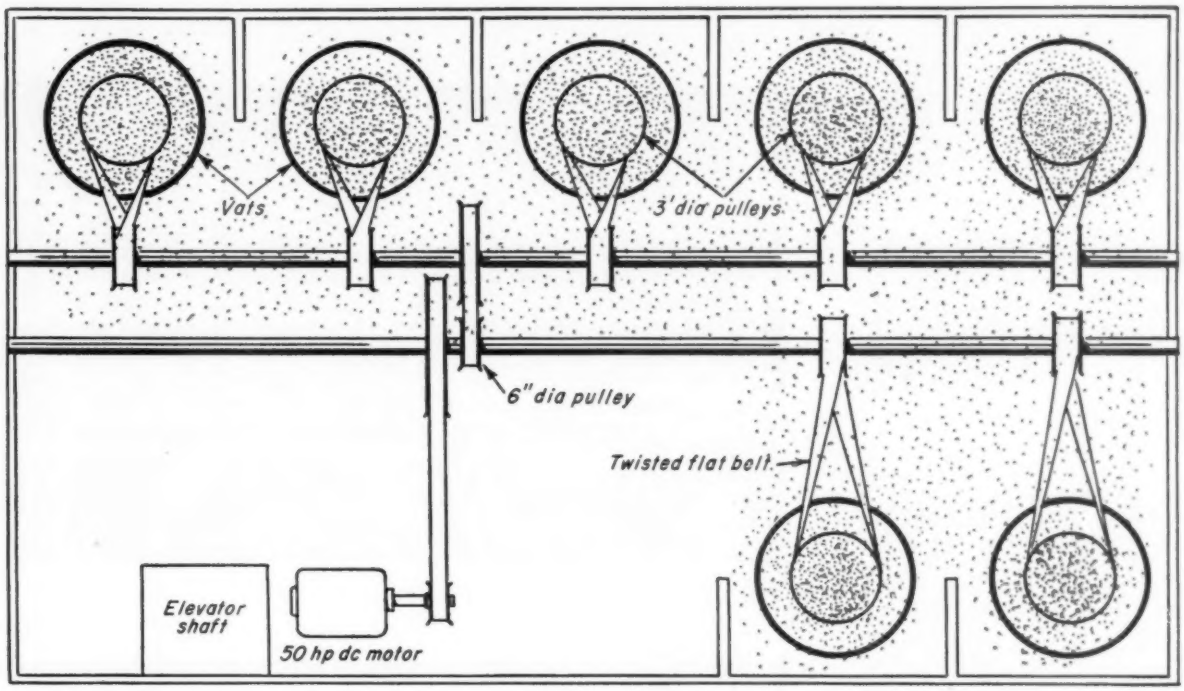
At one time individual motors were mounted over each vat. Coupled with a gear reducer, each powered agitators. But the corrosive action of the strong fumes destroyed them in a period of approximately four to five months, forcing the manufacturer to replace them.

Maintenance and replacement costs mounted. Downtime was necessary to complete replacement and installation of the damaged motors.

Added advantage of the single remotely placed motor, now used is that power needed for a special unit can be tapped at any time from the rotating

Right-angle gears synchronize film





REMOTE MOTOR transmits its power to vat-mixing pulleys through a long line shaft. This protects the motor from corrosive fumes shown in color.

overhead shafts. Starting and stopping agitators is easily done by slipping the belts off the shaft manually. This is possible because of the low 15-rpm.

Exception is made when certain vats have frequent starts and stops. Then a clutch is installed.

Solution of this corrosion problem was accomplished by engineers at the factory of an eastern shellac manufacturer.

winding pulleys

RIGHT ANGLE GEAR UNITS drive pulleys at synchronized speeds to operate a movie-film winding machine.

Driven in series by 1-hp, a-c, 3-phase, 1800 rpm, 220 volt motor, the pulleys are fitted with 40-tooth sprockets on the driving pulleys. Sprocket-teeth match perforations in the drying film, moving it at constant speed.

Problem facing the unit's designers was: How to drive the film through the drying machine and wind it without pull or lack of synchronization. This would break the film.

The motor-shaft turns a centrifugal coupling which transmits power but does not start with a yank, thus not adding stress to the film.

To slow speed, the coupling sends its power through a right-angle gear reducer with a reduction ratio of 25: 1.

Half-inch shaft transmits power from the reducer to the line-up of right-angle gear-transmission units. In order to maintain perfect alignment and synchronization at all times during operation, a series of couplings makes up the entire working shaft between each spindle.

Before using the right-angle gear units at 1:1 ratio, film breakage was a danger because of a lack of synchronization. This fault was eliminated in prelimary testing.

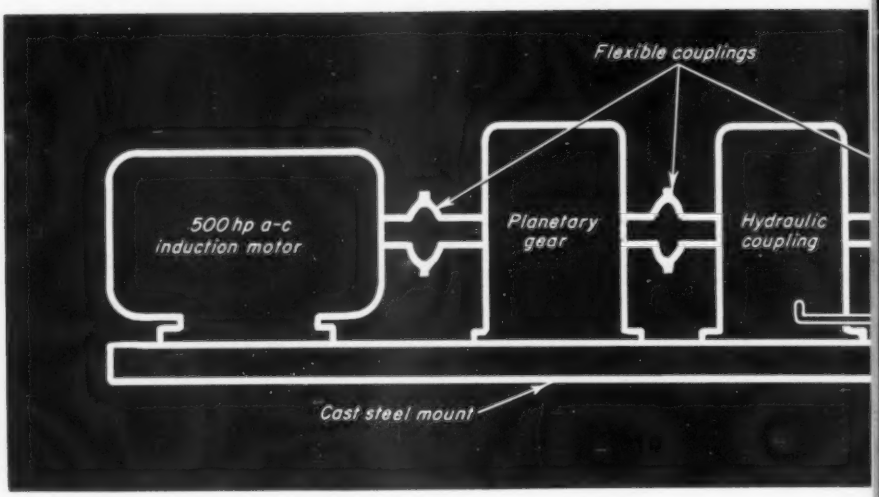
Pulleys of a special design are used to carry the moist film as it is going through the drying machine. These are two inches in diameter, are one and one-half inches in width, and have a sloping depression between the sides of the pulley, forming a groove. This keeps the soft, damp film from coming in contact with an abrasive surface.

Since only driver-pulleys are fitted with sprockets, the idler pulleys are allowed to rotate freely on their spindles. The flexible, multi-jaw couplings have eliminated any alignment difficulties. Film moves over the pulleys at the usual rate of 200 feet per minute.

Processing rate for positive film is 200 feet per minute while negative film moves at 100 feet per minute when necessary for development.

It operates efficiently at normal film-processing temperatures which may be in the range of 80°F to 100°F.

Unit was developed by engineers at *Twentieth Century Fox Film Corp.*, New York City.



CONSTANT speed control in spite of varying cycles is achieved by this organization of motor, gear increaser, hydraulic coupling, flexible coupling, pump, and centrifugal pump.

Hydraulic coupling produces constant speed

HYDRAULIC COUPLING slips, forcing a pump to hold constant rpm in spite of varying motor cycles (48 to 60 cps) in a municipal power station.

A small half-inch centrifugal oil pump is attached to the shaft-end of the larger pump. Sensitive to pressure-changes, as the large pump's rpm's drop, the small pump transmits a pressure-signal to the pneumatic diaphragm on the coupling. This controls slippage of the coupling, increasing or decreasing rpm as needed.

Units powering the large pump are linked together in this order. First: 500-hp a-c motor with rpms varying from 2800 to 3600, cycles varying from 40 to 60. Second: Planetary gear speed increaser with 1.4 : 1 ratio, input rpm's varying from 2800 to 3600, output rpm's varying from 4040 to 5040. Third: Hydraulic coupling with input rpm's varying from 4040 to 5040, output a constant 3600 rpm.

The problem arose when pump's user lowered frequency on his hydroelectric system as a conservation measure when water level dropped in the reservoir.

Gear train gets 30 turns from

GEAR TRAIN with a rack and pinion is rotated 30 turns by a 90 degree actuator.

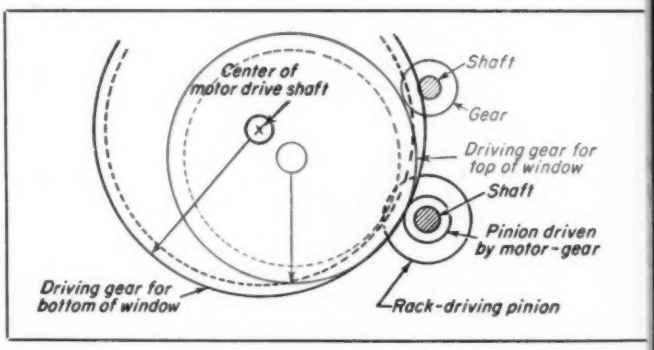
Rack is 20-pitch, 14½ degrees, ⅜-inch face width, with .325 pitch-line to back.

Pinion is 20-pitch, 28-tooth, 14½ degrees. Actuator motor is used to power the automatic raising and lowering of both a top and bottom window sash.

The problem was how to use a 90-degree motor that had enough torque but not enough turns to do the job. Motor is a reversible actuator, 24-volt, ac/dc, one amp. Time interval needed to sweep the 90-degrees is twenty seconds.

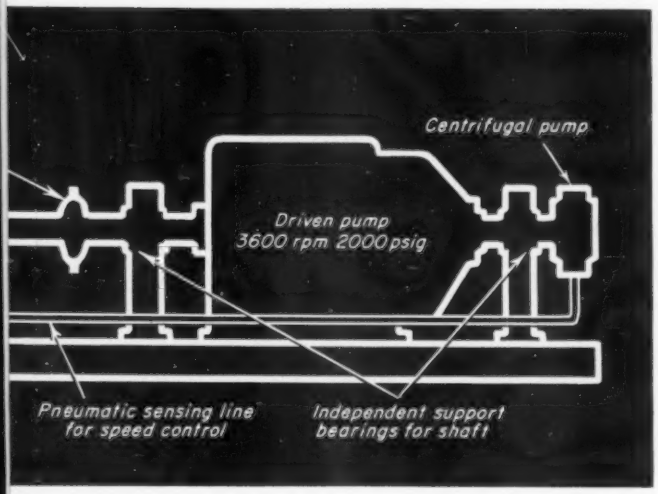
The lifting force is 100 lbs. Motor is connected in series with a low voltage transformer having primary: 120 volts, 60 cycles; secondary: 18 volts at 2 amps. The bottom window sash travels eleven inches while the top sash moves five and one-half inches.

Motor drives 8-inch diameter, 160-tooth gear, turning 28-tooth pinion on 4-ft long, ⅜-inch diameter shaft. Racks on top sash are 8-inches long, those on bottom sash are 16-inches long.



Because of the great difference between the diameter of the large gear and the small pinion, gear rotation is increased so as to lengthen the working span of the 90-degree motor-shaft.

Because space inside sash-area is limited, care in gear design was needed to make sure of adequate clearance between large gear on top-sash and pinion

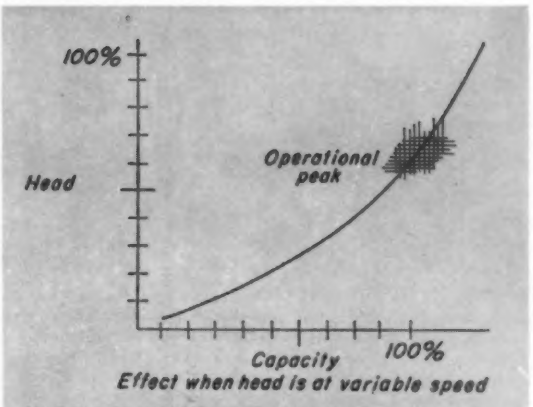


from varying frequencies

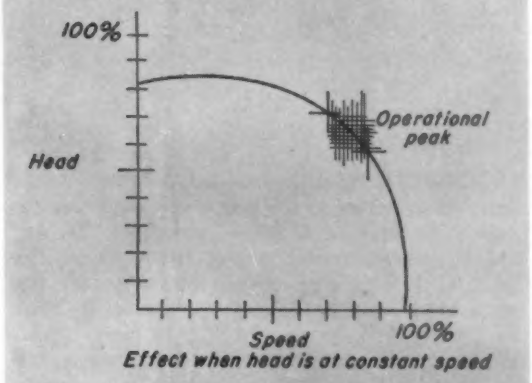
At a low of 48 cycles, highest rpm on the motor is 2800. Since hydraulic coupling has slippage of 10%, 3950 rpm is needed to get 3600 rpm's out of the unit.

The hydraulic coupling is automatically adjusted and re-adjusted by sensing centrifugal pump as speed of the turning shaft increases or decreases. Flexible couplings between units keep re-alignment constant.

The speed-adjusting power transmission arrangement is the development of *Paul W. Anderson Engineers*, New York City.

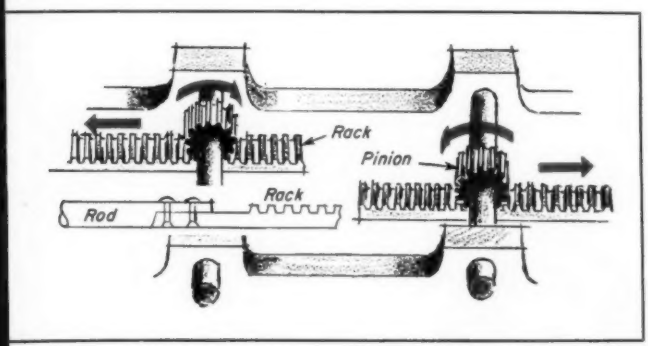


VARIABLE SPEED when plotted, gives this peak.



CONSTANT SPEED gives similar peak in arc segment. Both peaks give designed speed performance.

90-degree actuator



GEARS operate an opening-closing window sash, getting a maximum of 30 turns from a 90-degree actuator, in confined space at low cost. Detailed design of gear and pinion clearance is seen in diagram at left. Three dimensional drawing shows rack and pinion arrangement with adjacent shafts which operate window sashes.

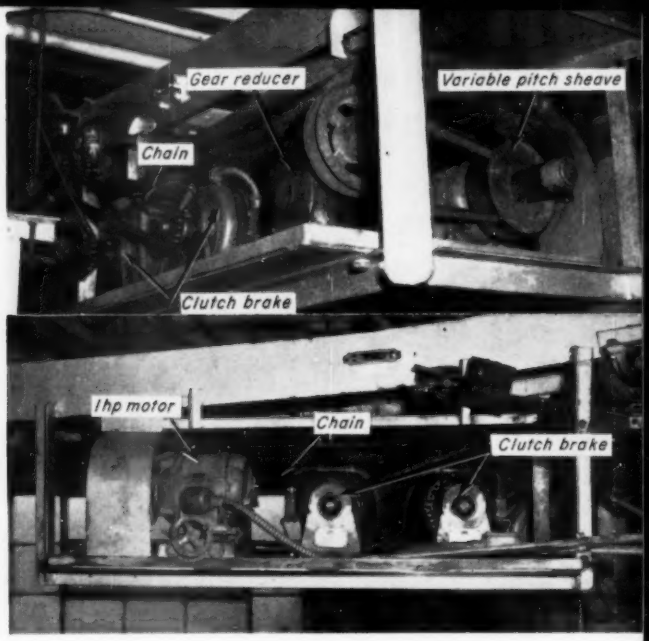
driving bottom-sash, as shown in drawing at center-left.

Racks and pinions move side by side in opposite directions as seen in the drawing at center-right.

Motor-shaft angularity is still 90-degrees. Because it was reversible, the window sash opens in primary direction until end of the rack is reached. Then, it reverses itself, returning the sash to a closed position.

Four pinions are used in each unit, two being used to operate the bottom sash, two for the top sash. Two motors supply power. Four gears make up the trains. Supporting the shafts are four pillow blocks, each equipped with self-lubricating, porous bronze bearings. All shafting, gears, racks and pinions are situated above the window and designed to take advantage of any space available.

Utilization of a 90-degree actuator reduced cost of this system considerably. The idea was developed by a firm of Manhattan Engineers.



MOTOR WITH CLUTCH BRAKE seen in back and front views at right, eliminated a motor and cut maintenance costs. Chains drive two conveyors from single electric motor. Each once needed its own motor. Detail drawing, center, shows arrangement of clutch brakes and motor. Far right hand drawing shows former floor plan with eliminated motors X'd out. Present motors and clutch-brakes are shown in color.

Clutch-brakes reduce maintenance,

CLUTCH-BRAKES, chain actuated, eliminate one of three electric motors, and reduce costly maintenance in a bakery.

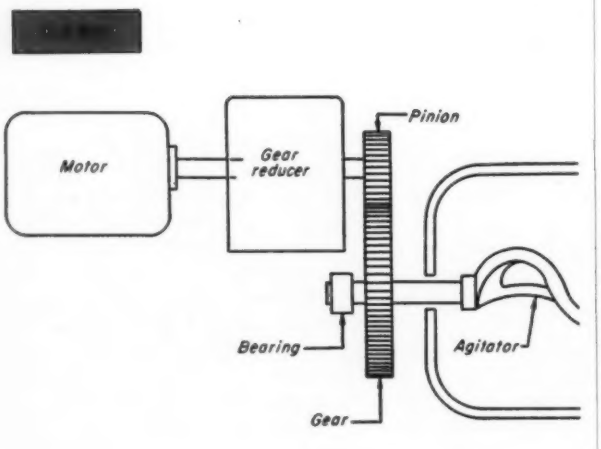
They allow the motor to run continuously. This eliminates the high temperature problem caused when motors are kept in steady start-stop operation. Previously, three brake motors, 1-hp, 1750 rpm, 3-phase, a-c, 220-440 volt were used. Maintenance was expensive. Stripped down three times a year, they were replaced annually. Another solution was magnetic brakes. This solved high temperature problems but not motor wear.

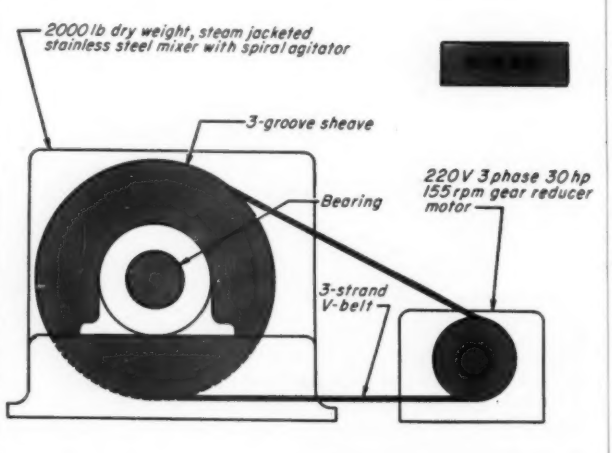
Braking is now accomplished by clutch brakes organized in such a way as to drive two conveyors off a single motor, eliminating need for the third motor.

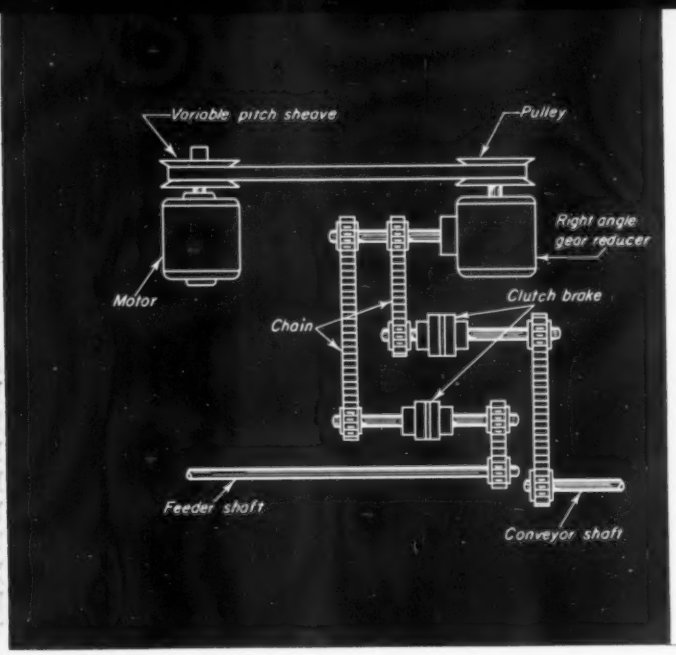
Running diameter of the clutch brake is 9-inches, overall length is 4-inches. Braking is accomplished by positive magnetic engagement of the shaft-mounted armature and stationary-mounted magnet.

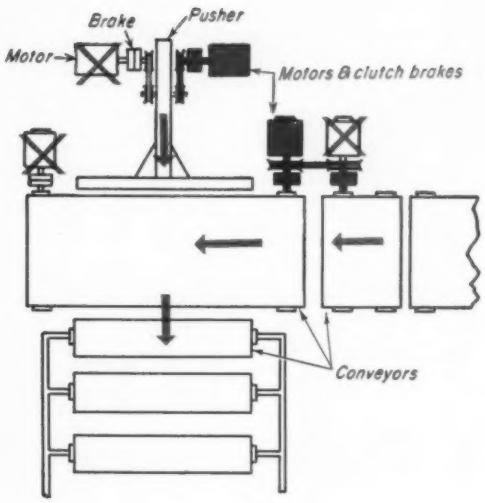
The electric clutch unit is energized through a col-

Three-strand belt, gearmotor




2000 lb dry weight, steam jacketed stainless steel mixer with spiral agitator
3-groove sheave
Bearing
220 V 3 phase 30 hp 155 rpm gear reducer motor
3-strand V-belt





eliminate motor

lector ring and a brush holder assembly. Power is transmitted to the through-shaft after lock-in of magnet and armature.

Motor used is same: 1-hp, 1725 rpm, a-c.

Power is transmitted through variable pitch sheave, v-belt, gear reducer, chain and sprocket and clutch brakes to shafts.

Variable pitch sheave has 6-inch diameter, 1500 rpm to 1725 rpm. A wide range v-belt drives a six-inch pulley. Gear reducer has ratio of 3 : 1. and transmits power to pair of 6-inch sprockets and chains, actuating separate clutch brakes as seen in center schematic above. Clutch brakes control flow of power to each shaft, powering either or both of the two conveyors independently.

The motor runs continuously at even temperature, brake actuates clutch, being released when clutch engages.

These units are installed in five *Bond Bread, General Baking Co.*, plants.

eliminate gear train

THREE-STRAND V-BELT DRIVE transmits power directly from a gearmotor to a mixing-vat agitator in a dye manufacturing plant.

Eliminated is an intermediate gear reducer, a gear train, and intense vibration.

Power is transmitted from a 30-hp, 3-phase, 155 rpm, 220-volt, gearmotor, via the three strand v-belt to a three-groove pulley. The driven pulley turns the agitating mixer-shaft against a 2000-lb. dry weight dye particles in a stainless steel mixer.

OLD WAY at far left shows how gears were once used to power the agitator-paddle of a dye-mixing vat. This caused floor vibration which could not be controlled, even though cork bases were installed beneath the vats.

NEW WAY at near left shows the three-strand v-belt unit now powering the agitator paddle on the dye mixer. Load moved is 2000 lb dry weight. A spiral agitator is used. Vibration is no longer a problem here.

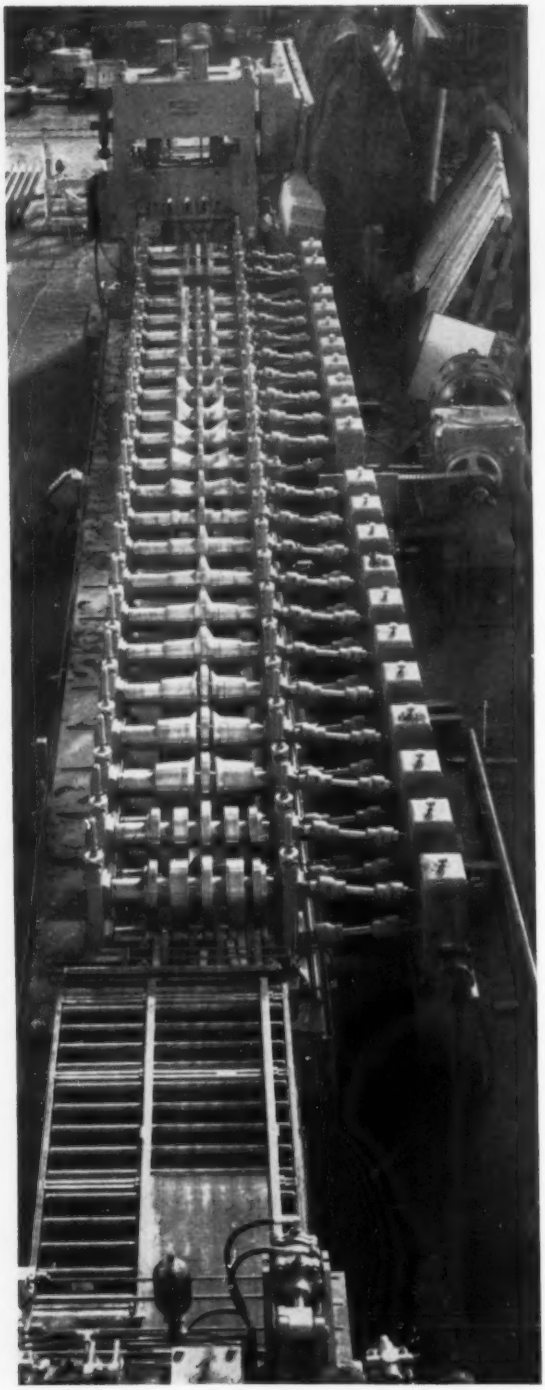
The entire transmission unit is mounted on cork base to further reduce vibration from plant flooring. Other methods previously were attempted. One was a multi-sprocket chain drive. Motors were coupled to the mixer, using gears and a pinion.

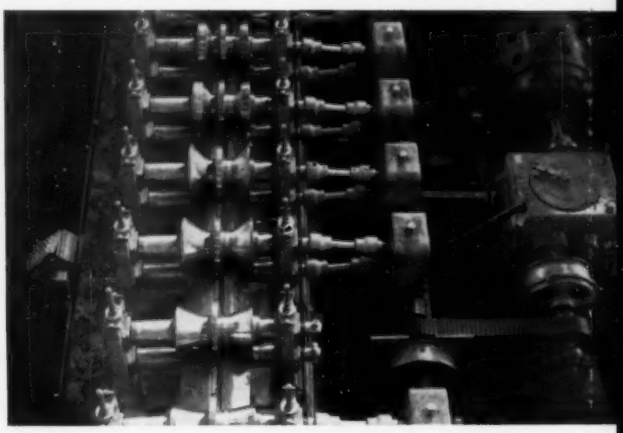
Motor used was 15-hp, a-c, 3-phase, 220-volt, 60-cycle, 1800-rpm. The gear reducer input was 1800 rpm, output 280. Pinion on the gear train cut rpm's to 49, that of the agitator blades.

Earlier, mixer agitator was turned by multi-pulley drives. This did not prove practical because of power loss, together with the fact that when mixers were elevated for discharge, belting room was lost. When gears cause vibration, one means of eliminating noise was attempted by mounting the motors and gears on cover plates. This did not stop the vibration, even through the brick pier and steel girders.

This gear motor and pulley installation is working in the *Park and Tilford Tintex Division*, New York City.

Ball and socket universal simplifies mill drive





EIGHTY-EIGHT ball-and-socket universal joints are used in the rolling mill shown above and left. Four at each of the 22 roll stands.

SLIP IN-OUT UNIVERSALS make roll disassembly easy on a 22-stand mill. The universals have pins extending through the balls to transmit torque to the sockets. Ends of the pins fit into rectangular blocks held by snap rings. The blocks mate with slots in the sockets to increase the bearing area between driving and driven members.

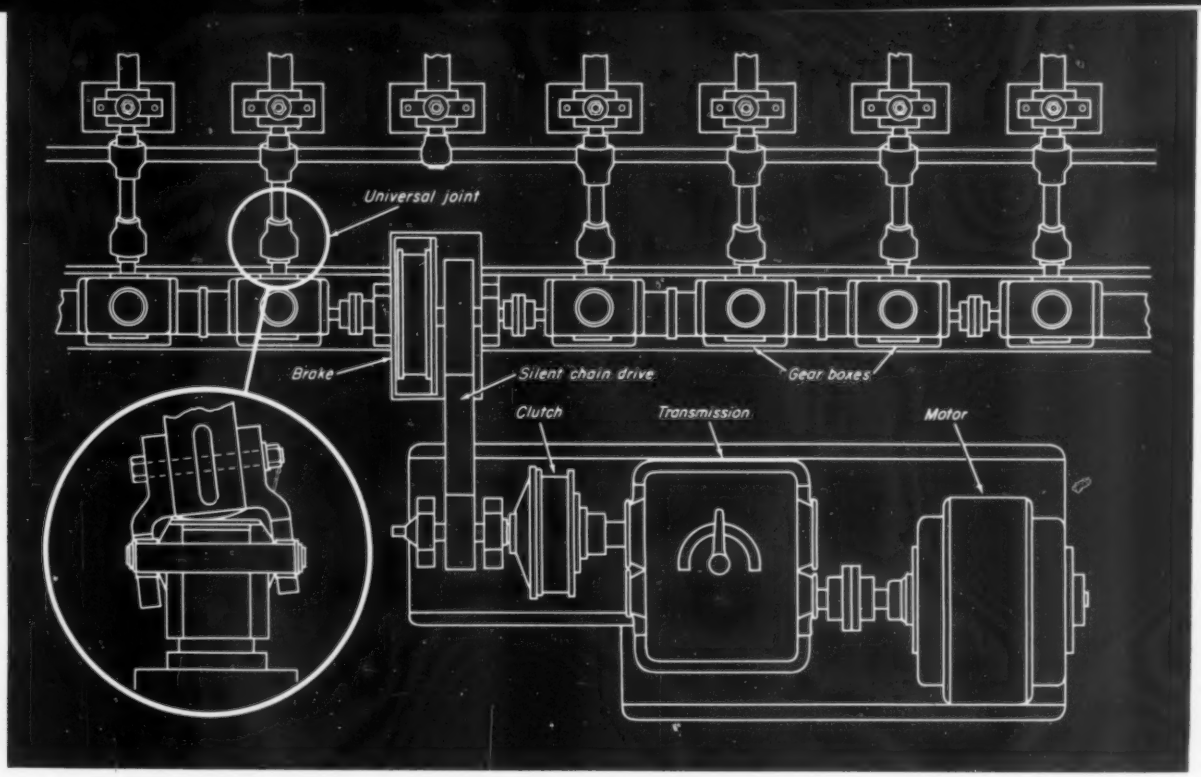
Because a ball and socket slip simply together, both assembly and disassembly are fast and easy. Any time a shaft must be removed to change rolls, the ball at the end of the shaft simply slips out of the socket.

Another advantage is that the ball and socket allow changes to be made in center distance. This is done by sliding the ball in and out of the socket. With conventional universals, a splined slip shaft must be used between the joints to allow this.

Universal joints are needed to drive the shafts because different roll diameters are used from stand to stand. Also, different work piece sections are rolled at different times on the mill. Flexibility of the universal shafts allows wide variation in roll spacing even though shaft centers of the gear boxes are fixed.

Power for driving the rolls comes from a 250-hp ac motor driving through a 4-speed, speed-reducing transmission, air clutch, silent-chain drive, and the series of special gear boxes. There are 22 gearboxes, one for each stand. The input shaft to each gearbox is built to permit coupling to the next gear box in line.

There are two output shafts on each gear box, one above the other, at right angles to the input shaft. The two output shafts drive the universal shafts of the roll stands. These shafts turn at the same speed, but in



CONSTRUCTION DETAILS of the ball-and-socket universal joints and a layout of the entire rolling mill drive system. Four-speed reduciing transmission gives rolling speeds of 52, 70, 90, or 105 fpm.

opposite directions.

The air clutch, which disconnects the 4-speed transmission from the silent-chain drive, is operated from any of three pushbutton control stations through solenoid valves. The electrical circuit is arranged to permit the same pushbutton to energize solenoid-controlled air-operated brake on the other end of the silent chain drive. The brake stops the entire system including all stands.

Cost is another reason for using ball-and-socket universals. The cost of each universal is considerably less than for the conventional crosstype and slip shaft joints. Saving per assembly is multiplied by 44 since there are two at each of the 22 roll stands.

This mill is designed and built by *The Yoder Co.*, Cleveland, Ohio for a Japanese firm. It can roll-form a variety of products of different flat sheet gages at speeds of 52, 70, 90, or 105 fpm. Initial production is to be made on an inverted W section roof deck used in building construction.

Electric motor automates welding process

ELECTRIC MOTOR-driven heliarc welding torch produces precision-welds automatically—and does it four times faster than the manual operations once used.

The motor drives a burning-carriage at a pre-determined speed. It travels on wheels along a track moving directly over the seam being welded. At one time welded by hand, the manual operation produced porous, rough looking welds. Cleaning them by grinding excess and polishing streaks used costly production time.

Top hand-welding speed was eight inches per minute. Automated and motor-driven, the new welding process moves at the rate of 36 inches per minute. If needed, it could move as much as 50 inches per minute.

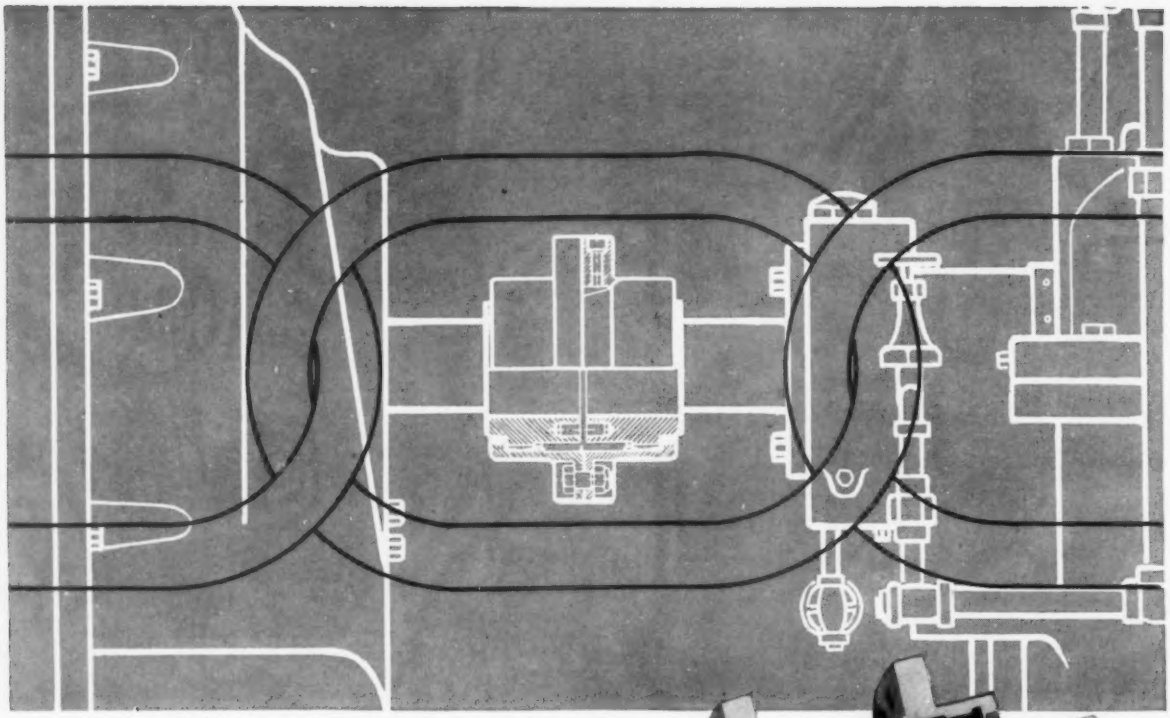
The motor is a-c single phase, 110 volts, 5 amps, and operates between 25 and 60 cycles, according to the speed needed in the welding process.

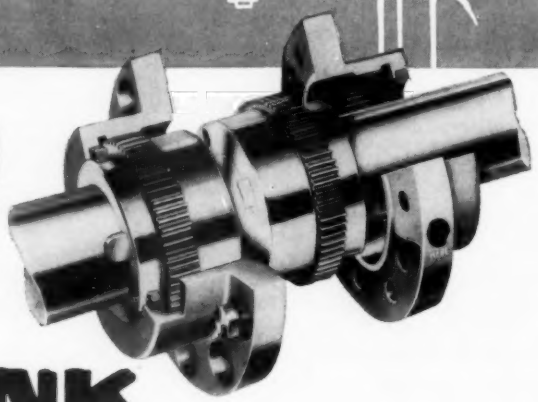
The motor-driven carriage supports and carries the torch, argon lines, and electric wires.

Automated-process welding is much more accurate. As the hand-welder's speed increased, his accuracy dropped accordingly. Accuracy also suffered because of the fatigue factor which was especially depleting at the top 8 ipm speed.

The apparatus makes use of a heliarc tungsten rod carrier. Electric current is transmitted in the shield of argon gas which keeps impurities from entering the field.

This electric motor application is the development of plant production engineers at *P. Feiner and Sons, Inc.*, in New York City.





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BEARINGS

DESIGN/APPLICATION

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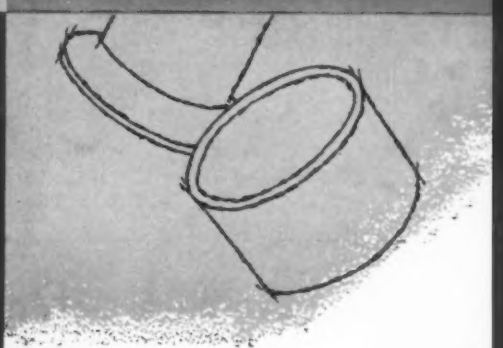

What is boundary lubrication

. . . in oilless bearings?

BY R. R. SLAYMAKER, *professor, Case Institute of Technology, consulting engineer, The Cleveland Graphite Bronze Co.*

SINTERED BEARINGS are called oilless bearings. They are designed to be used without external supply of lubricant. The journal surfaces in the bearing are made slippery, to reduce friction in several ways depending on the type bearing.

If the lubricant is a fluid (i.e., if it offers practically no resistance to change in form) and there is enough of it between the surfaces to separate them completely, fluid film lubrication exists. But if the layer of lubricant is so thin that there is partial metal-to-metal contact, boundary lubrication exists.

If the bearing is made of solid bronze, or steel-backed bronze, the surfaces might have indentations filled with graphite. If molded from powered graphite and bronze, or from sintered bronze powder, the bearing itself is porous and resembles a metallic sponge. This type bearing is impregnated with oil.

Since the diameter of the shaft is always smaller than the diameter of the bearing, and since the shaft is always harder than the bearing, the bearing will wear to fit the shaft.

Wear takes place as shown in Fig. 1. Wear action resembles that of a brake shoe having a contact angle θ with a brake drum of radius r. We find wear directly under the load to be

$$e = \sqrt{R^2 - r^2 \sin^2 \frac{\theta}{2}} - r \cos \frac{\theta}{2} - c \text{ in.}$$

$$= r \sqrt{1 - \sin^2 \frac{\theta}{2} + \frac{c}{r}\left(2 + \frac{c}{r}\right)} - r \cos \frac{\theta}{2} - c$$

which suggests a dimensionless equation involving the clearance ratio c/r of the form

$$\frac{e}{r} = \sqrt{\frac{c}{r}\left(2 + \frac{c}{r}\right) + \cos^2 \frac{\theta}{2}} - \cos \frac{\theta}{2} - \frac{c}{r}$$

in which e/r is called the wear ratio. Wear ratios as a function of the contact angle θ for clearance ratios of 0.0008, 0.001, and 0.0015 are shown in Fig. 2.

Adapted from Bearing Lubrication Analysis, by R. R. Slaymaker; published by John Wiley & Sons, Inc., N. Y.

Unit Load and Contact Angle

The amount of material that wears away in a given time, as one surface rubs against another, is generally proportional to the product of the normal pressure and the rubbing velocity. If shaft speed is held constant, the rate of wear in a radial direction is proportional to the radial presure. Since the rate of wear in the direction of the load is a constant, the radial pressure as shown in Fig. 3 is

$$p = p_{max} \cos\phi$$

in which p_{max} occurs directly under the load where ϕ is zero.

From Fig. 3, the summing forces in the direction of the load W gives

$$W = p_{max} r L \int_{-\frac{\theta}{2}}^{+\frac{\theta}{2}} \cos^2 \phi \, d\phi$$

$$= p_{max} r L \frac{\sin\theta + \theta}{2}$$

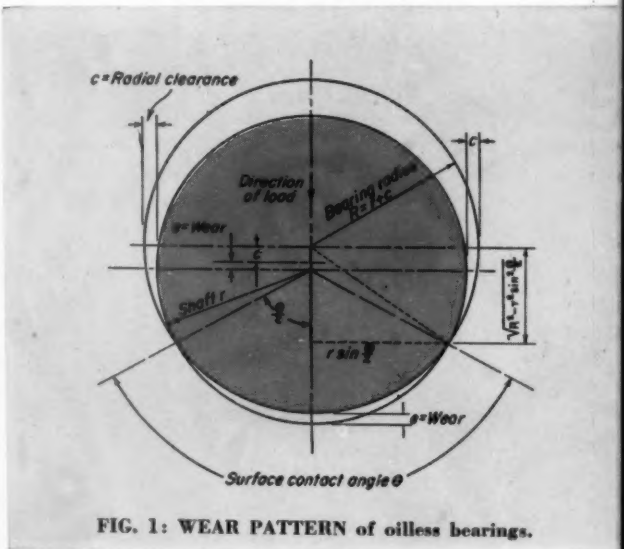

FIG. 1: WEAR PATTERN of oilless bearings.

Substituting the unit load ρ for $W/2rL$

$$\rho_{max} = \frac{4}{\sin\theta + \theta}\rho \frac{\text{lb}}{\text{in.}^2}$$

Thus for a given unit load and a given contact angle, ρ_{max} is known. It is this value of ρ_{max} which should be less than some constant divided by the rubbing velocity, if wear is not to progress too rapidly. Hence

$$\rho_{max} < \frac{k}{V} \frac{\text{lb}}{\text{in.}^2}$$

Here ρ_{max} is the maximum pressure against the bearing in pounds per square inch, V the rubbing velocity in feet per minute, and k a constant which must be determined by experiment for every bearing material with its own particular kind of permanent lubrication.

As the velocity decreases, the permissible pressure ρ_{max} increases, but ρ_{max} should be less than the compressive yield point of the material. This puts another restriction on the maximum pressure, so that

$$\rho_{max} < \frac{k}{V} < S_{yp}$$

where S_{yp} is the yield point of the bearing material.

Eliminating ρ_{max} gives the unit load in terms of the contact angle to be

$$P < \frac{k}{V} \times \frac{\sin\theta + \theta}{4} < S_{yp}$$

Values of $(\sin\theta + \theta)/4$ for various values of θ are given in Fig. 2.

Modification of Unit Load

These formulas are of value from a quantitative standpoint because they show how load, speed,

Continued on next page

Sample Problem

Let

d = 1 in. journal diameter
L = 1 in. bearing length
$\frac{c}{r}$ = 0.001 clearance ratio.
N = 2000 rpm journal speed
k = 70,000, a value that gives satisfactory bearing life
S_{yp} = 10,000 $\frac{\text{lb}}{\text{in.}^2}$ the yield point of the bearing material

(1) Determine the unit load P and the probable angle of Contact corresponding to a wear e of 0.0002 in.

(2) Determine the unit load and probable contact angle if the wear were restricted to 0.0001 in.

Solution

(1) if $e = 0.0002$, $e/r = 0.0004$, and from Fig. 2 the curve for $c/r = 0.001$ gives the angle of contact $\theta = 90°$.

Then from the curve of $(\sin\theta + \theta)/4$ against θ, find that, if $\theta = 90°$, $(\sin\theta + \theta)/4 = 0.64$. From the speed of the shaft and the shaft diameter, the velocity V is 523.6 ft per min and

$$P < \frac{70{,}000}{523.6} \times 0.64 < 10{,}000$$

and

$$P < 85.6 \text{ lb per sq in.}$$

(2) If $e = 0.0001$, $e/r = 0.0002$, and, following the procedure giving above, $\theta =$ about 70°,

$$\frac{\sin\theta + \theta}{4} = 0.54$$

and

$$P < 72.2 \text{ lb per sq in.}$$

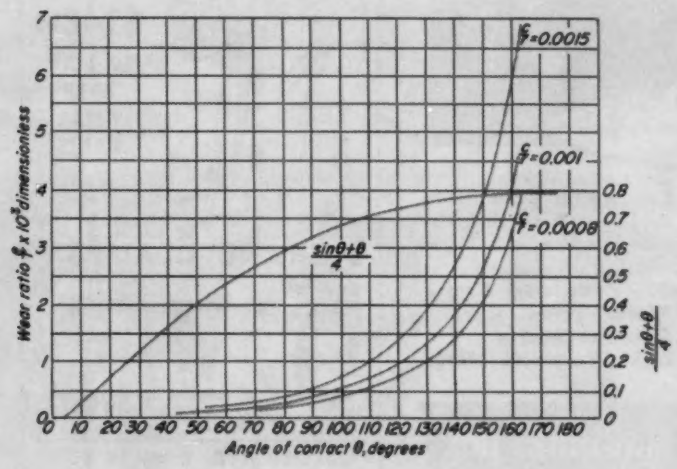
Wear ratio $\frac{e}{r}$ x 10^3 dimensionless
$\frac{c}{r}$=0.0015
$\frac{c}{r}$=0.001
$\frac{c}{r}$=0.0006
$\frac{\sin\theta+\theta}{4}$
$\frac{\sin\theta+\theta}{4}$
Angle of contact θ, degrees
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180

FIG. 2: WEAR RATIO vs angle of contact θ.

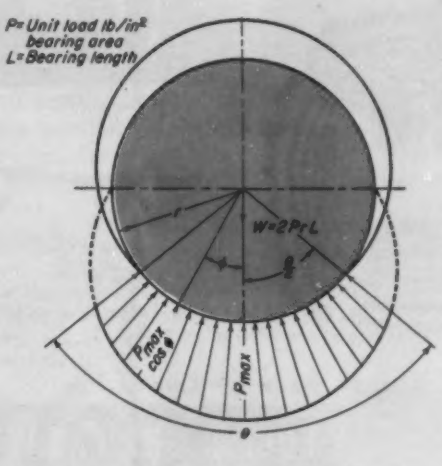

FIG. 3: PRESSURE DISTRIBUTION pattern.

Are you getting the lion's share?

There's a huge portion of meaty information between the covers of each issue of Power Transmission Design Magazine. Make sure you've gotten the most out of this one before you pass it along. Leaf through it again, particularly noticing things like **New Products,** starting on page 51, and **Useful Literature,** starting on page 58. If you need details on any of them, the Reader Service Cards will bring them to you promptly.

clearance, and bearing material are related to wear and arc of contact. Numerical answers from them do not mean much, however, because of the uncertainty of the wear constant k. Even if k were a precise number, the unit load for a given clearance could still vary considerably, depending on the amount of wear that can be permitted. One large company, manufacturers of powered metal products, recommends

$$PV \leqq K$$

provided P does not exceed the static strength of the material.

Constant K is an experience factor which has been determined for each of their sintered, oil-impregnated bearing materials. The most common material is 90% copper, 10% tin for which the constant K is 50,000, and the maximum static unit load is 8500 lb per sq in. The recommended clearance ratio for this type of bearing is about 0.83×10^{-3} for most applications.

A more convenient form is one in which the unit load is in terms of the shaft diameter and shaft speed. Thus with $K = 50{,}000$, the equation becomes

$$P \leqq \frac{191{,}000}{dN} \quad \frac{\text{lb}}{\text{in.}^2}$$

Applying this equation to the example

$$P \leqq 95.5 \text{ lb/in.}^2$$

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MEETINGS

APRIL 14-15

Society of Automotive Engineers, Central Illinois Section, Tenth Annual Earthmoving Industry Conference, Peoria, Ill.

APRIL 18-22

American Society of Tool Engineers, annual meeting, Schroeder Hotel, Milwaukee, Wis. Contact: Harry E. Conrad, executive secretary, ASTE, 10700 Puritan Ave., Detroit, Mich.

APRIL 22-24

Institute of Environmental Engineers, 3rd annual technical meeting and equipment show, Chicago, Ill.

APRIL 21-23

American Society of Lubrication Engineers, 14th annual meeting and lubrication exhibit, Hotel Statler, Buffalo, N. Y. Contact: C. Willey, executive secretary, 84 E. Randolph St., Chicago, Ill.

MAY 4-8

National Industrial Production Show of Canada, Exhibition Park, Toronto, Canada. Contact: E. M. Wilcox, 19 Melinda St., Toronto, Canada.

MAY 12-14

American Society of Mechanical Engineers, production engineering conference, Statler-Hilton Hotel, Detroit, Mich.

MAY 25-28

American Society of Mechanical Engineers, Machine Design Div., design engineering conference and show, Convention Hall, Philadelphia, Pa. Contact: Clapp & Poliak Inc., 341 Madison Ave., New York 17, N. Y.

MAY 26-28

Anti-Friction Bearing Manufacturers Association, annual meeting, Drake Hotel, Chicago, Ill. Contact: H. O. Smith, secretary-manager, 60 E. 42nd St., New York, N. Y.

MAY 31-JUNE 3

American Gear Manufacturers Association, annual meeting, The Homestead, Hot Springs, Va. Contact: J. C. Sears, executive director, One Thomas Circle, Washington 5, D. C.

JUNE 14-18

American Society of Mechanical Engineers, semiannual meeting, Chase-Park Plaza Hotel, St. Louis, Mo.

JUNE 14-19

Society of Automotive Engineers, summer meeting, Chalfonte-Haddon Hall, Atlantic City, N. J. Contact: Robert W. Crary, public relations manager, SAE, 485 Lexington Ave., New York 17, N. Y.

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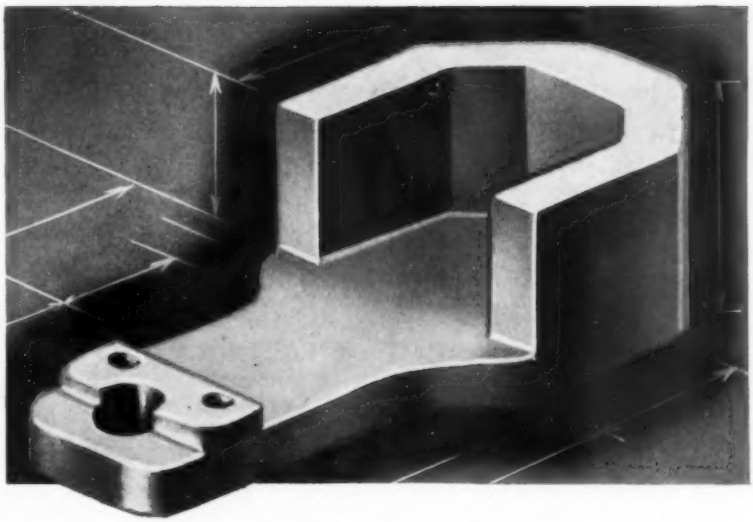

The photograph shows a bearing support plate for a new line of power tools manufactured and marketed by a large and very capable organization.

The complex nature of the part is apparent at a glance and the cost of machining such a part is evident to the eye of engineer and designer.

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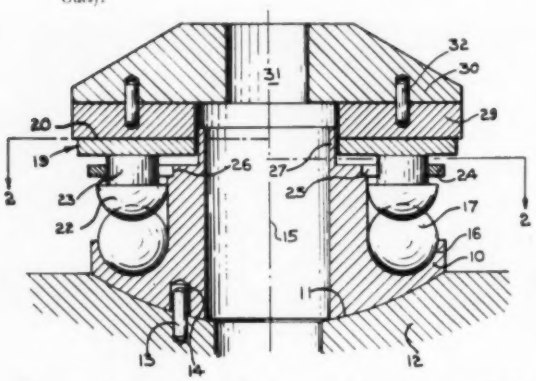
PATENTS

Self-equalizing thrust device

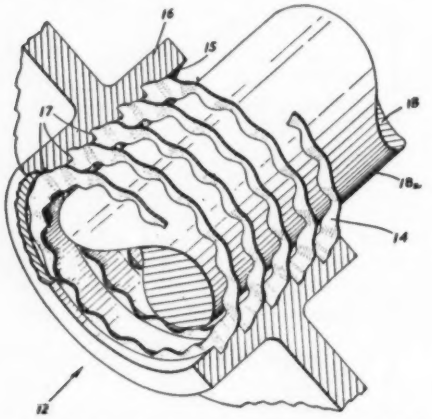
U. S. Patent 2,871,070; *Eustace S. Dunn, Piedmont, Calif.*



This equalizing thrust device consists of a rotatable thrust pad, a series of irregular quadrilateral thrust shoes to each of which is attached a hemispherical pivot ball, a number of equalizing balls, and a base. The shoes contact the thrust pad; the pivot balls, attached with their round faces away from the shoes, each rest on two equalizing balls which ride in an annular recess in the base, and tend to force the equalizing balls apart.

Labyrinth Seals

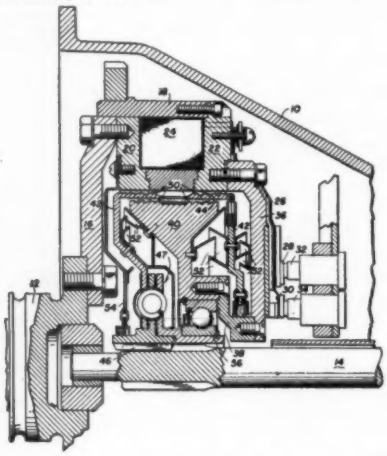
U. S. Patent 2,871,038; *Peter Dennis Comery, Cooksville, Ont., Canada, assignor to Orenda Engines, Ltd., Malton, Ont., Canada.*



This seal consists of a mounting surface which is a surface of revolution, in which is cut an uninterrupted helical groove, with a metallic strip of helical configuration seated in and brazed in the groove. There are crimps in the strip, each crimp extending from one side to the other, and being of greater magnitude adjacent the edge of smaller radius than adjacent the edge of larger radius. The width of the groove is substantially equal to the distance through which the material of the strip is displaced in forming the crimps along one of the edges of the strip, so the ridge of each crimp will contact the edge of the groove and form, in association with the side of the groove, an area of capillary attraction for the molten brazing material to secure the strip in the groove.

Magnetic Clutch

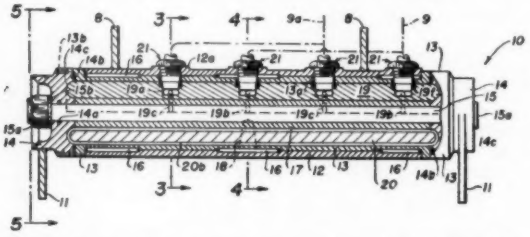
U. S. Patent 2,870,888; *Andrew S. Gill Jr., South Euclid, Ohio, assignor to Eaton Manufacturing Co., Cleveland, Ohio.*



Magnetic clutch consists of a pair of driving members, one fitting concentrically within the other, and with a space between them. The first member includes a pair of axially-spaced pole portions and an electromagnetic coil between them for providing a magnetic field. The driven member includes a spaced plate disposed axially on both sides of the second driving member and a sleeve portion in the opening between the two drivers, the spaced plate providing a pair of axially-spaced gaps with magnetic material in the gaps responsive to the magnetic field.

Rotary Actuator

U.S. Patent 2,870,748; *Carl A. Hemphill, Los Angeles, Calif., assignor to North American Aviation, Inc.*

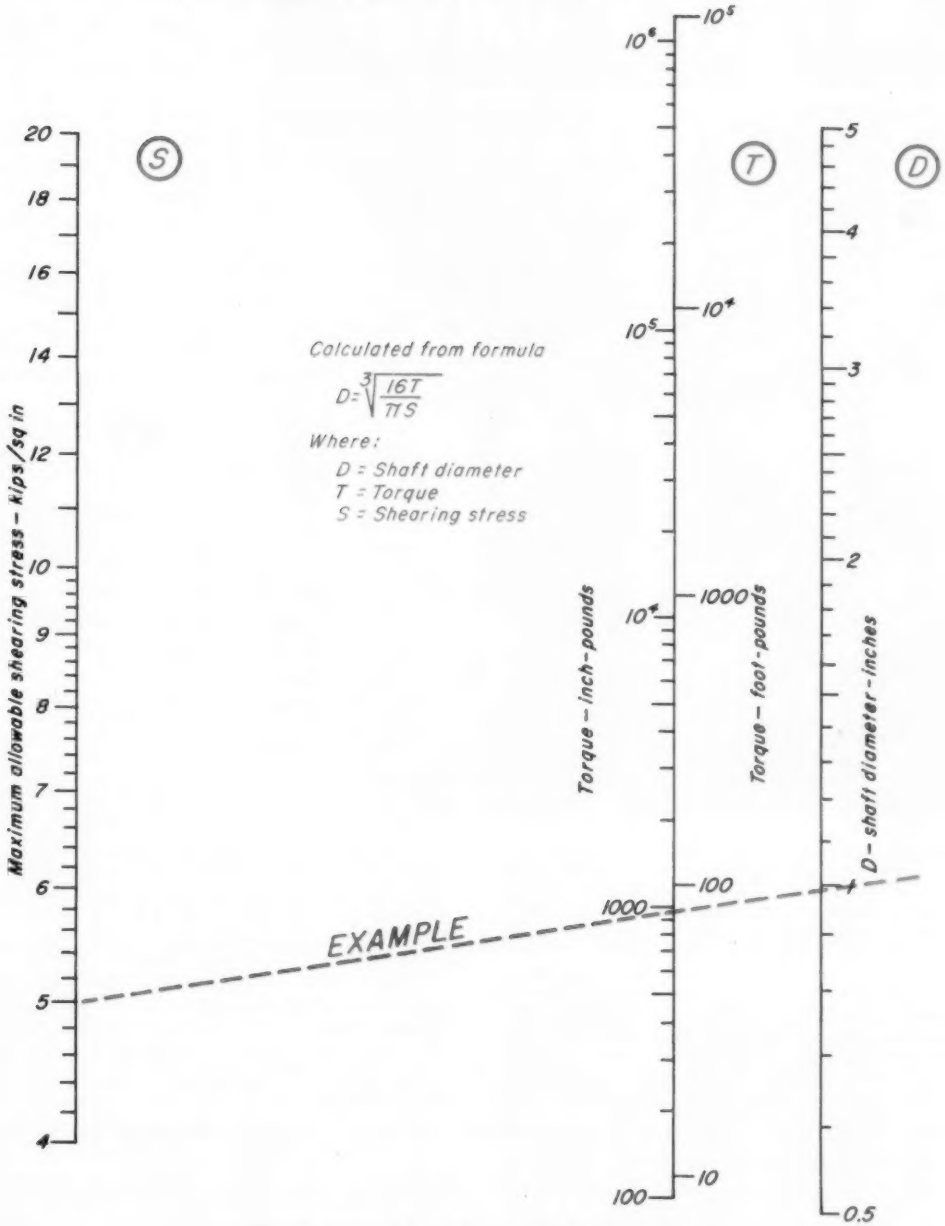


This patent refers to an improved method of sealing pistons in rotary fluid motors having a fixed cylindrical casing, a piston rotating on a longitudinal axis within the casing and journalled within torus-shaped head elements which form the ends of the casing. The improvement consists of a peripheral groove formed within the edges of the piston and a continuous elongated O-ring carried in the groove.

REFERENCE FILE

Nomogram of shaft shearing stress

By J. N. ARNOLD, *professor, Purdue University*



EXAMPLE SHOWS that for a shaft of 1 in. dia, carrying a load of 1000 in.-lb, shearing stress is 5 kips per square inch (5000 lb per sq in). Shearing stress is caused by torsional load.

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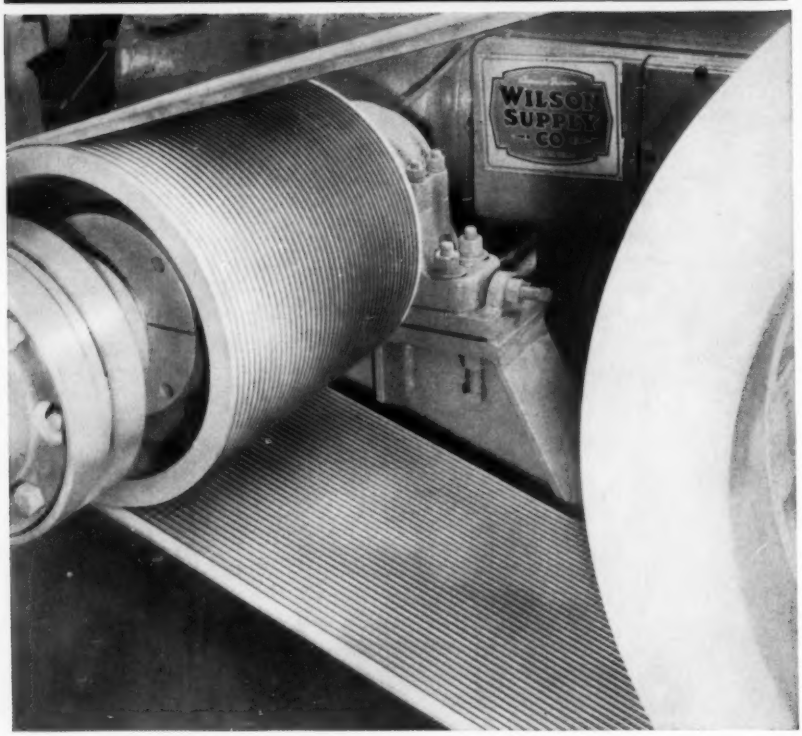
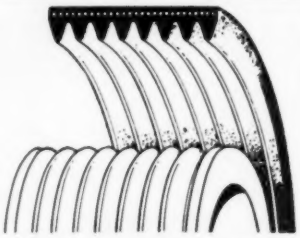
When you change drives...
Don't Settle for *Less* than the BEST

CONVERT TO RELIABLE R/M POLY-V® DRIVE!

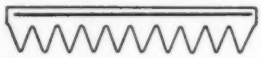




- **ELIMINATES "MATCHING" PROBLEMS**

A SINGLE UNIT across full width of sheave—NOT an assembly of SEVERAL V-BELTS

Poly-V



V-Belts

- **MORE UNIFORM POWER**
- **IN LESS SPACE**

Uninterrupted strength member full width of sheave provides higher horsepower capacity with less stretch —in less space.

- **MAINTAINS GROOVE SHAPE**
- **COMPLETE CONTACT-PRESSURE**
- **MORE CONSTANT SPEED RATIO**

Sheave grooves do not wear out of shape. Full and complete contact-pressure of rubber-to-sheave maintains groove profile. Maintains constant pitch and speed ratio.

..."MORE USE PER DOLLAR"

This gas compressor drive was rough on V-belts . . . until Wilson Supply Company installed trouble-proof R/M Poly-V Drives on all 200 HP units. Today, R/M's patented, space-saving transmission drive assures a degree of power-packed performance and dependability not possible with any available V-belt drive!

Major causes of V-drive trouble are engineered *out* of Poly-V Drive. It features a single unit, V-ribbed belt—*not* an assembly of V-belts that become unmatched and prevent complete power delivery. Full contact between Poly-V Belt ribs and specially designed sheave grooves keeps belt position constant . . . maintains groove shape and profile regardless of wear—with less wear on belt and sheaves even under toughest drive conditions! Speed ratio is unchanged. And because Poly-V Belt has uniform, uninterrupted strength member across the sheaves, Poly-V Drive will reliably deliver up to 50% *more* power in the same space as a multiple belt drive—or equal power in as little as ⅔ the space!

Let an R/M representative show you how Poly-V* Drive can give you more power delivery, more drive dependability . . . "More Use per Dollar" than the drive you now use. Just two cross sections of Poly-V Belt meet every heavy duty power requirement. Write for Bulletin M141 T. D.

WHEN YOU CHANGE DRIVES...CONVERT TO R/M POLY-V DRIVE AND BE SURE!

*Poly-V is a registered Raybestos-Manhattan trademark.

RM-354

BELTS • HOSE • ROLL COVERINGS • TANK LININGS • INDUSTRIAL RUBBER SPECIALTIES

MANHATTAN RUBBER DIVISION — PASSAIC, NEW JERSEY

RAYBESTOS-MANHATTAN, INC.

Other R/M products: Abrasive and Diamond Wheels • Brake Blocks and Linings • Clutch Facings • Asbestos Textiles • Mechanical Packings • Engineered Plastics • Sintered Metal Products • Industrial Adhesives • Laundry Pads and Covers • Bowling Balls

For more information circle no. 28 on the Reader Service Card

NEW PRODUCTS

Two-step gearheads multiply both torque and speed in a wide range

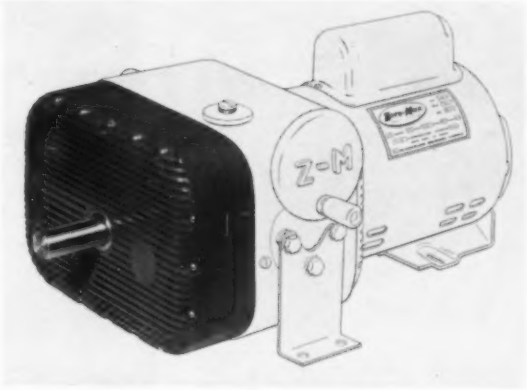
New two-step gearheads multiply by 4-½ times the speed range or torque of Zero-Max speed controls. This means that you can get a speed range of 0 to 2000 rpm and a torque limit of 450 inch-lb from the Zero-Max infinitely variable speed control.

For those interested in obtaining these gearheads, or who have potential applications for these items, may find they offer an answer to their needs.

The gearheads are available in eight ratios, from 2:1 to 5:1, and from 1:2 to 1:5. They are housed in a short extension of the Zero-Max case so they become an integral part of the unit, with common lubrication.

Zero-Max, Minneapolis, Minn.

Circle No. 200 on the Reader Service Card



Take up frame fits any ball, roller, or babitted pillow block

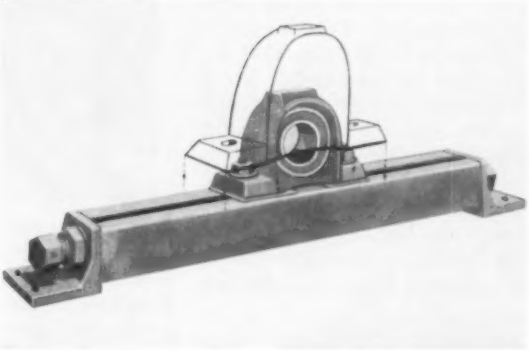
Any pillow block now on the market—whether ball, roller, or babitted—can be accommodated by the new Versa Mount take-up frame. What's more, the frame can be top or side mounted; loosening a locknut permits the mounting flange to be swung either way.

The Versa Mount is available in a wide range of sizes and travel lengths from 2 inches to 36 inches, accommodating pillow blocks from ½ inch to 2 7/16 inches.

In addition to take-up application, the mount is suggested for motor base, head shaft support, and similar uses.

Lovejoy Flexible Coupling Co., Chicago, Ill.

Circle No. 201 on the Reader Service Card



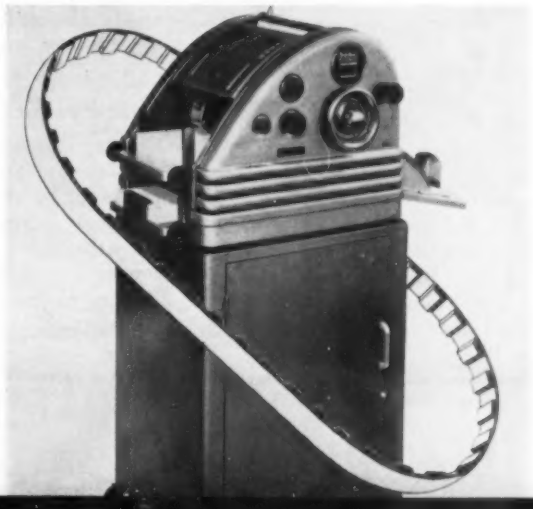
Toothed-belt drive replaces steel bands on duplicating machine

An endless, toothed-belt drive is being used, in place of steel bands, at no increase in price, on Tempo-Geha Stencil Duplicators. The belt is said to provide silent running, non-slip positive drive, and almost unlimited life. It is strengthened with endless steel strands.

This is an excellent example of the application of the toothed, endless belt as a transmitter of driving power when silence of operation is a prime need. Duplicators are used in business offices or other places where quiet operation is essential to the comfort and efficiency of persons working near the machine or with it.

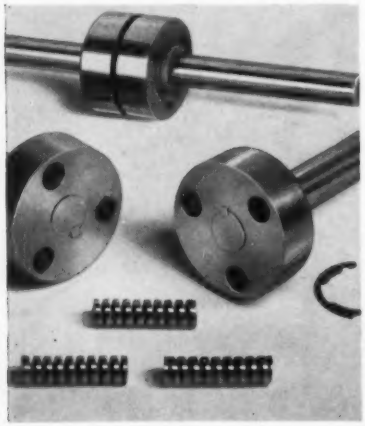
Milo Harding Co., Monterey Park, Calif.

Circle No. 202 on the Reader Service Card



Free-aligning coupling

No nuts or bolts are used in the couplings. Machinery can be connected or disconnected with a screwdriver. Halves are joined and transmit thrust through helical wire springs held in place by snap or split rings. Couplings operate in either di-



rection of rotation. They can be vertically installed without parts change.

Shock absorbing, it allows maximum misalignment. Load factor is 7:1. Available in any size, they are standardized in three series: Light, shaft diameter up to 2 inches; Medium, shaft diameter 2 inches to 5 inches; Heavy, diameter from 5 inches to 12 inches. Larger diameters are available on special models.

Atomatic Mfg. Co., East Pittsburgh, Pennsylvana.

Circle number 203 on reader service card

Combination gear units

Speed reducers with ratios ranging up to 10,000:1; horsepower ratings from fractionals to 168-hp with higher hp-ratings supplied in special cases, are described in a 96-page pocket-size booklet containing complete technical data on speed reducer and gear selection.

Also included are data on horsepower ratings, torque ratings, and ratios, and installation instructions for convenience of engineers, designers, and draftsmen. All units described are self-contained in dustproof, oil-tight, rigid semi-steel housings. Gears are between bearings.

Abart Gear and Machine Co., Chicago, Illinois.

Circle number 204 on reader service card

High-temp ball screwjacks

Ball screwjacks that can operate in temperatures up to 1700 F and have a mechanical efficiency of over 90 percent are being manufactured in this country under license from Rotax, Ltd., of Great Britain.

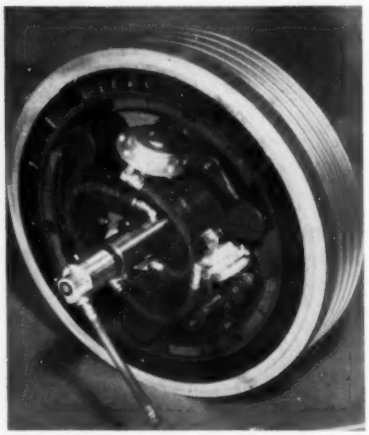
These screwjacks come in sizes up to 40,000-lb load-carrying capacity, 4-inch shaft diameter, and 88-inch length.

Walter Kidde & Co., Inc., Belleville, N. J.

Circle number 205 on reader service card

Clutch pulley

Variable speed clutch pulley is basically a slipping clutch with an outside drive pulley and an air cooled clutch inside. Outside pulley shell is belted to a power source and rotates at a



constant speed. Inner clutch assembly takes power from the outer-pulley shell, transmitting it through a center shaft. The clutch is activated by static air pressure and the greater the pressure applied, the greater is the speed of the clutch assembly. It increases until reaching belted speed of the outside pulley-shell.

Horton Mfg. Co., Inc., Minneapolis, Minnesota.

Circle number 206 on reader service card

Speed reducer

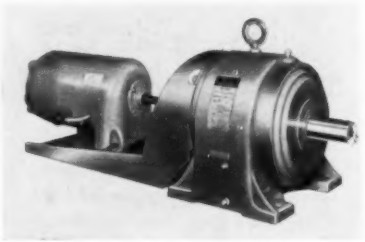
Gives speed reduction ratios of 100:1. A primary motor and the reducer are connected by a d-c clutch. They use a common drive shaft. Primary motor gives the high-speed output, the Motoreducer gives the low speed output. Ratings go from ½ to 40 hp.

Reuland Electric Co., Alhambra, Cal.

Circle number 207 on reader service card

Gear reducer combination

Combined gear reducer and gear-shift drive unit give four or eight speeds on the gear reducer's output shaft. Line includes double and triple



gear reduction units. Motor capacities are rated from 1-hp to 10-hp, and the combination is designed for applications where more than one speed is needed on the output shaft. By moving the shift level, four different output shaft rpm's are obtainable on the gear reducer.

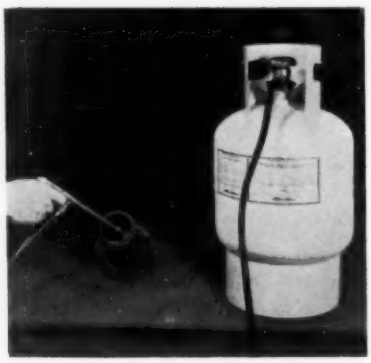
Two-speed motor gives eight different speeds. Standard electrical characteristics: constant torque, 3-phase or 2-phase, 60 cycle 208, 220/440, or 550 volts.

The Lima Electric Co., Inc., Lima, Ohio.

Circle number 208 on reader service card

Non-flammable lubricant

Non-flammable colloidal lubricant, a dry-film material packaged in a large-size industrial aerosol. Named DGF 123, the colloidal graphite is carried in a .7% concentration at 34 psi to 38 psi, room temperature, in



a fluoron propellant that dries instantly.

Control elements carried with the synthetic colloidal graphite give even dispersion and high affinity for clean, dry metallic surfaces.

Miracle Power Products Corp., Cleveland, Ohio.

Circle number 209 on reader service card

Miniature tach generator

By redesign, weight of a miniature tachometer generator for jet aircraft has been cut by more than half, with a comparable cut in size, and with no sacrifice in performance. The new

generator, which weighs 12 oz compared to 26 oz for the old, is directly interchangeable with the previous model. It's a two-pole, three-phase unit, rated for continuous operation at 350 F.

General Electric Co., Instrument Dept., West Lynn, Mass.

Circle number 210 on reader service card

Stopper cuts grinder's downtime

A new magnetic stopping device simplifies the stopping of grinding mills for manhole access and reduces motor wear and strain.

The stopper consists of a magnetic limit switch attached to a non-moving part of the mill and a magnetic operator installed on the revolving frame. The limit switch is wired into the same circuit as the push-button station that controls the starting and stopping of the mill. When the magnetic operator revolves past the switch, the button is pushed, interrupting the circuit. The mill then coasts to a standstill. Once the amount of coasting has been determined, it is simple to install the control at a point which will bring the manholes into position for easy access.

Without this type of stopping device, it's necessary, either to keep stopping and starting the mill to baby the manholes into position, or to equip the mill with an inching device. The new device can be installed on any grinding mill now in the field.

Allis-Chalmers Manufacturing Co., Milwaukee, Wis.

Circle number 211 on reader service card

Torque tilting base

Reaction torque tilting motor base for automatic belted drive tension control under changing load conditions is available in bases to accomodate all NEMA sizes through frame 505, as well as for special applications calling for larger frames.

The motor base's reactive torque is directly proportional to the horsepower. Belt tension increases and decreases as the load varies.

Allis-Chalmers Mfg. Co., Milwaukee, Wisconsin.

Circle number 212 on reader service card

Worm gear transmission

Worm and planetary gear transmissions rated at 225 ft-lbs, at 8 rpm output. Heat treated worm is of high

carbon alloy steel. Worm gear of two-piece construction, has bronze alloy gear portion. The sun gear is cut from a gray iron casting containing chromium and vanadium. Planet gears are heat treated steel. Ring gear is cut integral with gray iron housing. Ratio is 220:1.

Merkle-Kroff Gear Co., Chicago, Illinois.

Circle number 213 on reader service card

Adjustable-speed drive

The VarEPack adjustable-speed drive operates from a-c lines, eliminating the need for current conversion equipment. It is connected directly to the load, eliminating the need for belts and clutches. It consists of an induction motor, an operator's control station, and a control cabinet containing a motor-starter, a set of power control tubes, and a closed-loop regulating system designed to link motor output to desired speed, tension, position, pressure, flow or other variable.

VarEPack comes in horsepower ratings from 1 to 50, and for maximum speeds from 1130 to 3400 rpm. Standard drives are 208/220/440 or 550 v, 3-phase, 60 cycles. Two-phase drives are available as specials.

Electric Products Co., Cleveland, Ohio

Circle number 214 on reader service card

Pillow blocks

Ball bearing pillow blocks known as the LP series and consisting of a precision, one-piece, malleable unit, ready for assembly on the shaft. Each unit is permanently sealed and prelubricated for life.

The units are now available in these sizes: ¾ inch, ⅞ inch, 15/16 inch, 1 inch, 1-13/16 inches, 1¼ inches, 1⅜ inches, and 1-7/16 inches.

Sealmaster Bearing Div., Stephans-Adamson Mfg., Co., Aurora, Ill.

Circle number 215 on reader service card

Speed reducers

Speed reducers lead the list of sections included in this 166-page pocket-size paper back book. Other sections cover: Stock and Special Gears, 48 pages; Sprockets, 16 pages; and Tables and Data, 26 pages.

Drawings and tables are printed as helps to designers and engineers. Gear Tooth data, Horsepower ratings and allowable tooth loads for spur gears, lists of stock spur gears, bevel gears and miter gears, worm gears and helical gears—all are arranged in convenient form.

Stock sprockets with tables of speed ratios for sprocket combinations, instructions on how to calculate chain length, and directions for center-distance calculating are listed.

The Ohio Gear Co., Cleveland, Ohio.

Circle number 216 on reader service card

Speed changer kit

Designers, lab technicians and instructors can quickly assemble a complete bantam speed changer in any of 29 ratios, from 1:1 to 44:1, with this new speed changer kit.

The kit comes in a durable carrying case, complete with gears, shafts, housing, gear gage, tube of grease, lubricant, allen wrench, and instructions. The gears are 48-pitch, 20-degree pressure angle spur gears of case-hardened steel; the input and output shafts run in two ball bearings on each shaft; and the countershafts run in high-quality, ground, needle bearings. Since the gears and housings all come from the company's standard bantam line, the kit's versatility may be increased by purchasing additional components.

Ratings: torque, 130 oz-inch maximum at low speed shaft; speed, 10,000 rpm maximum at high speed shaft; horsepower, 0.1-hp maximum at low speed shaft.

Metron Instrument Co., Denver, Colo.

Circle number 217 on reader service card

Reversing Clutch

There's no need to throw in a clutch or shift gears when you want to change direction or speed of travel with the Revers-O-Matic drive in a new torque converter transmission. A single throttle lever does the job: moving it from the neutral (center) position to one side engages the hydraulically-operated clutch; moving it farther increases the speed. Going back through neutral in the opposite direction gives you reverse. This arrangement gives smooth, fast acceleration, with no danger of stalling the engine as there is no direct mechanical connection between the power and the load. The absence of shock is claimed to reduce maintenance of axles, bearings, differentials and gears.

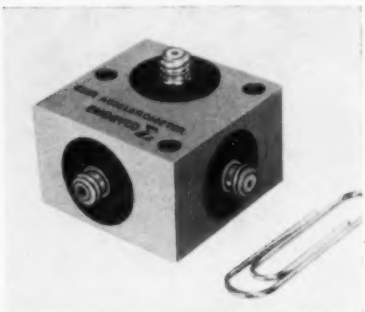
Tests show that the converter multiplies engine torque more than 200 percent. The drive is adaptable to any two-way movement, such as forward and reverse, or lift and lower, on engines with up to 250 cu in displacement. If it's advantageous to leave the operator's hands free, two foot pedals may replace the throttle lever.

Funk Manufacturing Co., Coffeyville, Kan.

Circle number 218 on reader service card

3-axis accelerometer

A tiny accelerometer that fits within $\frac{5}{8}$ cu-inches and weighs only 1.4 oz offers accurate simultaneous measurement of vibration in three axes.



Labelled the Model 2223, it uses three Endevco Piezite Type I sensing elements mounted on mutually perpendicular axes. Each separate axis is calibrated 20 to 4000 cycles per second ± 5 percent before installation in the accelerometer. The finished unit operates over a temperature range of —65 F to 220 F, and has a frequency response of 2 cps to 2000 cps ± 5 percent with a 1000 megohm load.

Endevco Corp., Pasadena, Calif.

Circle number 219 on reader service card

Mill lube system

Grinding mill operators have one less detail to worry about when the Lubritol system is installed. This system automatically provides continuous lubrication for trunnions and bearings, both while the mill is running and during the cooling off and starting periods.

A $\frac{1}{2}$-hp motor drives two pumps —one high and one low pressure. The high-pressure pump continuously supplies oil directly beneath the trunnion, floating the trunnion in the bearing. Additional low pressure oil is deposited either at the top of the trunnion or incoming chamfer of the bearing to assure complete lubrication. One Lubritol system is required for each bearing.

The oil is circulated and continuously filtered to remove all particles above 25 microns and absorb any water that condenses in the bearing's interior. A thermostatically controlled heater element in the bearing reservoir keeps the oil at about 80°F, even when room temperatures drops below freezing.

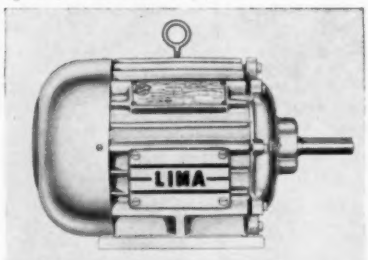
The Lubritol system can be installed on both new and existing equipment.

Allis-Chalmers Manufacturing Co., Milwaukee, Wis.

Circle number 220 on reader service card

Enclosed, fan-cooled motors

A new line of re-rated NEMA Type-E totally enclosed, fan-cooled electric motors is designed for use in non-explosive atmospheres containing excessive moisture or abnormal amounts of dirt and abrasives. They can be furnished for standard horizontal, wall or ceiling mount, and are available for all standard commercial frequencies and voltages below 600 V. Outputs range from 1 hp, 900 rpm (Frame 213) through 40 hp, 3600 rpm (Frame 326 U).



These motors come in seasoned cast iron frames with integrally cast feet. Integrally cast fins provide heat dissipation surfaces. The cast iron connection boxes can be rotated to make connecting easier.

Solid die-cast aluminum rotors have dual fans, and the entire rotor assembly is dynamically balanced. The double-width ball bearings are sealed, so require no lubrication or cleaning. The stators are impregnated with moisture-resisting, thermosetting varnish. High-velocity air from the external fan blows over the cooling fins, and at the same time keeps the motor clean.

Lima Electric Motor Co., Inc., Lima, Ohio.

Circle number 221 on reader service card

Versatile gearmotor

New fractional horsepower gear motor is designed for use in both universal and induction applications. As a universal a-c/d-c or shunt motor, it has ratings from 1/70 hp to 1/4 hp and a torque output up to 60 inch-lb, depending on the ratio used. As an induction motor, it's available in two-pole or four-pole models from 1/70 hp to 1/15 hp. Gear ratios range from 10:1 to 60:1. Both types use the same Model A-26 reduction unit; this is combined either with the Model 2900 induction motor, or the Model 25-500 universal motor.

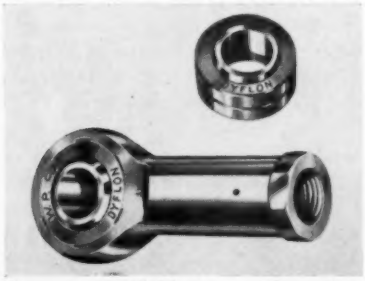
Mounting pads are provided on the gear unit for stable coupling, and are also available on the motor housing if required. The gear unit can be mounted in various positions on the housing. Motor and gear unit can be changed or serviced independently by removing external locking screws.

Howard Industries, Racine, Wisc.

Circle number 222 on reader service card

Self-lubricating bearings

Dyflon bearings are self-aligning, self-lubricatng bearings for applications requiring a low coefficient of friction, long service life and high dynamic load-carrying capacity.



They are available in a wide variety of plain and rod-end types, in bore sizes from 3/16 to 6 in. Rod-end types comes with either externally or internally threaded shanks.

Southwest Products Co., Monrovia, Calif.

Circle number 223 on reader service card

Shaft-turbine engine

The 860-hp T53-L-1 is the first shaft-turbine helicopter engine in its class to go into production in this country. It is slated for seven different helicopters and STOL (short take-off and landing) aircraft. Several higher-powered models are now being tested by the manufacturer.

Lycoming Div., AVCO Mfg. Corp., Stratford, Conn.

Circle number 224 on reader service card

Servo motors

Size 10 and 11 geared servo motors, available in a wide range of ratios, with reductions up to 8000:1, measure only 2-17/64 inches in length. Also available are size 10 and 11 hysteresis synchronous motors measuring 1-11/32 inches in length; these latter are six-pole units with a pull-in torque of 0.12 oz-inch and operating at 8000 rpm. Both

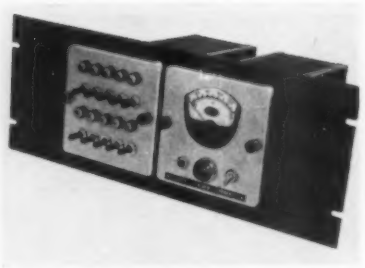
the geared and the hysteresis synchronous motors are available for 26, 55 or 115-v a-c 400-cycle operation; they're both designed for use in ambient temperatures from —65 to 125 C.

Western Gear Corp., Electro Products Div., Pasadena, Calif.

Circle number 225 on reader service card

Bearing heat monitor

Capable of monitoring a nearly unlimited number of points continuously, new system makes extensive use of thermistor sensing devices, whose electrical resistance changes with changes in temperature. Suggested applications include the monitoring of temperatures in bearings in generators, turbines, pumps and other rotating equipment.



The thermistors are mounted at the points to be monitored, and the electrical outputs from ten thermistors are tied together in a single monitor module, although alarm temperature for any of the sensing elements may be set individually. The output of ten modules (100 thermistors) is fed into a single alarm indicator module. An abnormal temperature situation at any of the sensing points will cause an imbalance in the electrical network at its monitor module and set of an alarm indication at the alarm module. By switching each of the sensing probes successively into the temperature indicating circuit, the point of abnormal temperature is quickly found. If it's desired, the alarm indicator can be installed to automatically initiate equipment shutdown or other protective measures.

The system is designed for rack or panel mounting. The modules measure 5-½ inches square x 11-½ inches deep. Input is 110 or 220 v, 60 cycles; the alarm circuit is rated at 5 amp.

Fenwall Incorporated, Ashland, Mass.

Circle number 226 on reader service card

Powerful reversing transmission

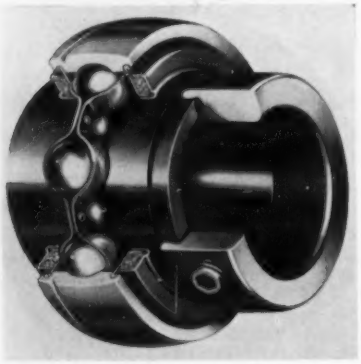
A small but mighty reversing transmission is used on a new ballast maintenance car for railroad track care. The Model 5201 reversing transmission combines gearbox, clutch, countershaft and mounting brackets in a single unit that is only 11-½ x 13 x 14-⅜ inches, yet transmits up to 38 hp. Reduction ratio is 3.16:1 both forward and reverse. Reversing is said to be smooth and quick under a full load. Suggested applications include power rollers, tractors, conveyors and hoists.

Snow-Nabstedt Gear Corp., Industrial Div., Hamden, Conn.

Circle number 227 on reader service card

Collar lock bearings

Eccentric collar, which secures ball bearing unit to a machine shaft, is a self-tightening type that provides easy and positive locking up-



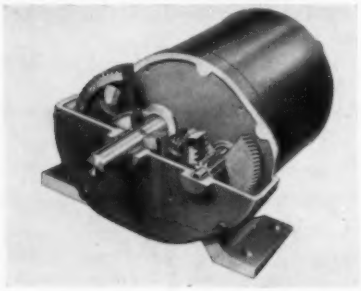
on installation. The bearing unit comes with either a spherical seat for automatic self-alignment or a straight outer diameter for more rigid, accurate shaft location. The bearings come either sealed for life or with channels in the outer bearing for relubrication. They are available in 32 shaft sizes, from ¾ to 2-15/16 in.

Hoover Ball and Bearing Co., Ann Arbor, Mich.

Circle number 228 on reader service card

Gearmotor

Low-cost gearmotor uses an integrally-mounted ¼-hp split-phase motor. Suggested for either intermittent



or continuous duty on small conveyors, rotating or revolvng displays, etc., the gearmotor provides speeds of 30, 60, or 120 rpm, with developed torques up to 433 inch-lb. Gears are precision-cut, for high strength and quiet operating; gear housing is cast aluminum. Weight is 18 lb, and size is 6 x 8-½ x 11 inches. It operates off 115 v a-c. Model is the VX10.

Von Weise Gear Co., St. Louis, Mo.

Circle number 229 on reader service card

Speed reducers

These rugged speed reducers for oil pumping equipment incorporate a magnetic cleaner to remove metallic impurities from the lubricant. Self-adjusting oil wipers on the sides of the gear are designed to assure a steady return of oil to the bearings regardless of operating direction.

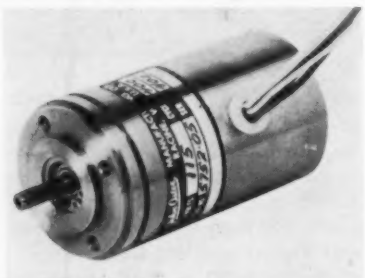
The one-piece housing is made of alloy gray iron. It is jig bored for true alignment and maximum tooth contact. Multiple-rib support for the slow-speed shaft and additional ribbing at input and intermediate shafts contribute to stability. The gears and pinions are made from heat-treated steel forgings and heat-treated alloy shafting. Herringbone gearing is precision generated on Sykes machines; helical gearing is produced by hobbing, followed by crown shaving, for accuracy and even distribution of stresses. All shafts are equipped with antifriction bearings, designed for life far in excess of minimum AGMA standards, according to the manufacturer.

Alten Foundry and Machine Works, Inc., Lancaster, Ohio

Circle number 230 on reader service card

Adjustable damped motor

An adjustable viscous damped motor for feedback damping applications is smaller, lighter and less expensive than the motor tachometer it's designed to replace; it also uses less power and presents no null or phasing problems. Damping and gain may be independently adjusted; no-load speed can be easily adjusted anywhere between 4800 and 7300 rpm,



depending on the damping characteristic required in the system. Model number of this size 11 unit is 5752-05. It meets Military Specification E-5272A; ambient temperature range is —55° to 125°C.

John Oster Manufacturing Co., Avionic Div., Racine, Wisc.

Circle number 231 on reader service card

Magnetic clutch

Compressed, miniature unit is designed for close applications. Length is .500 inch from cap-end to servo-flange. The servo-mounting diameter is 1 inch. It has a minimum torque clutch of 6 oz; will not drop a 2.5 oz load while switching from brake to clutch. Power consumption is 4.5 watts, response is 8 millisec.

Autotronics, Inc., Florrissant, Mo.

Circle number 232 on reader service card

CRITICAL SPEEDS

continued from page 24

when you specify and buy rotating equipment? The old rule in the pulley and sheave industry is—call for dynamic balance when rim speed exceeds 500 fpm.

Examination of this rule, however, reveals certain faults. A narrow face pulley can run faster than 5000 fpm statically balanced since it has practical dynamic balance because of its narrow face width. A wide pulley, on the other hand, might have severe vibration well below 5000 fpm if weight distribution is uneven along the face width. So, there must be consideration of face width to determine when to dynamic balance.

Most static balancing machines are sensitive to eccentricity, which shows up in the degree of remaining unbalance in lb-inches. This is a fixed percentage of the weight and can be represented by any established factor, such as 0.001 x W or, 0.0005 x W, where W is weight.

The weight of a pulley is a function of diameter times face width.

$$W = k \times F \times D \quad \text{.....(1)}$$

where k is a constant and is different for different wheels, such as sprockets, gears, sheaves, pulleys, etc.

If this formula is correct, then pulleys of all shapes and diameters, but of given weight, will produce roughly the same degree of vibration when mounted on a given shaft running at a given speed. But, this does not work out dynamically since some degree of dynamic unbalance remains in each pulley after static balancing. The wider face pulley will have a higher degree of dynamic unbalance. If we assume that this degree of dynamic unbalance is directly proportional to width, then unbalance is proportion-

tional to width, then unbalance is proportional to D x F^2 x eccentricity
Centrifugal force is

$Cf = k \times W \times rpm^2$ .....(2)
$= K' \times F \times D \times rpm^2$ .....(3)

Applying this extra F to allow for dynamic unbalance, the formula for vibration intensity at a given speed is proportional to

$k'' \times F^2 \times D \times rpm^2 = \text{vibration}$ (4)

To find the value of k", it is necessary to fall back on experience. A 20-inch diameter sheave with a 3-inch face width runs with an acceptable amount of vibration when statically balanced. Using this as a benchmark, then

$$\frac{1}{K''} = 3^2 \times 20 \times 1750^2 = 5.5 \times 10^8$$

or, any combination of $F^2 \times D \times rpm^2 = 5.5 \times 10^8$

A plot of these curves is shown.

Pulleys mounted between two bearings will, for a given amount of unbalance, produce less vibration than overhung pulleys. Pulleys between bearings can run twice as fast as overhung pulleys. The curve shows speed on the right side for a given diameter and face width beyond which dynamic balancing should be done, when running between bearings. Below this speed, static balancing is probably good enough. The left hand data is for overhung pulleys.

There is nothing absolute about this chart. Each manufacturer and each user who wants to do his own thinking will have to make up his own value of k" based on his experience for each type of pulley, sheave, sprocket, gear or flywheel.

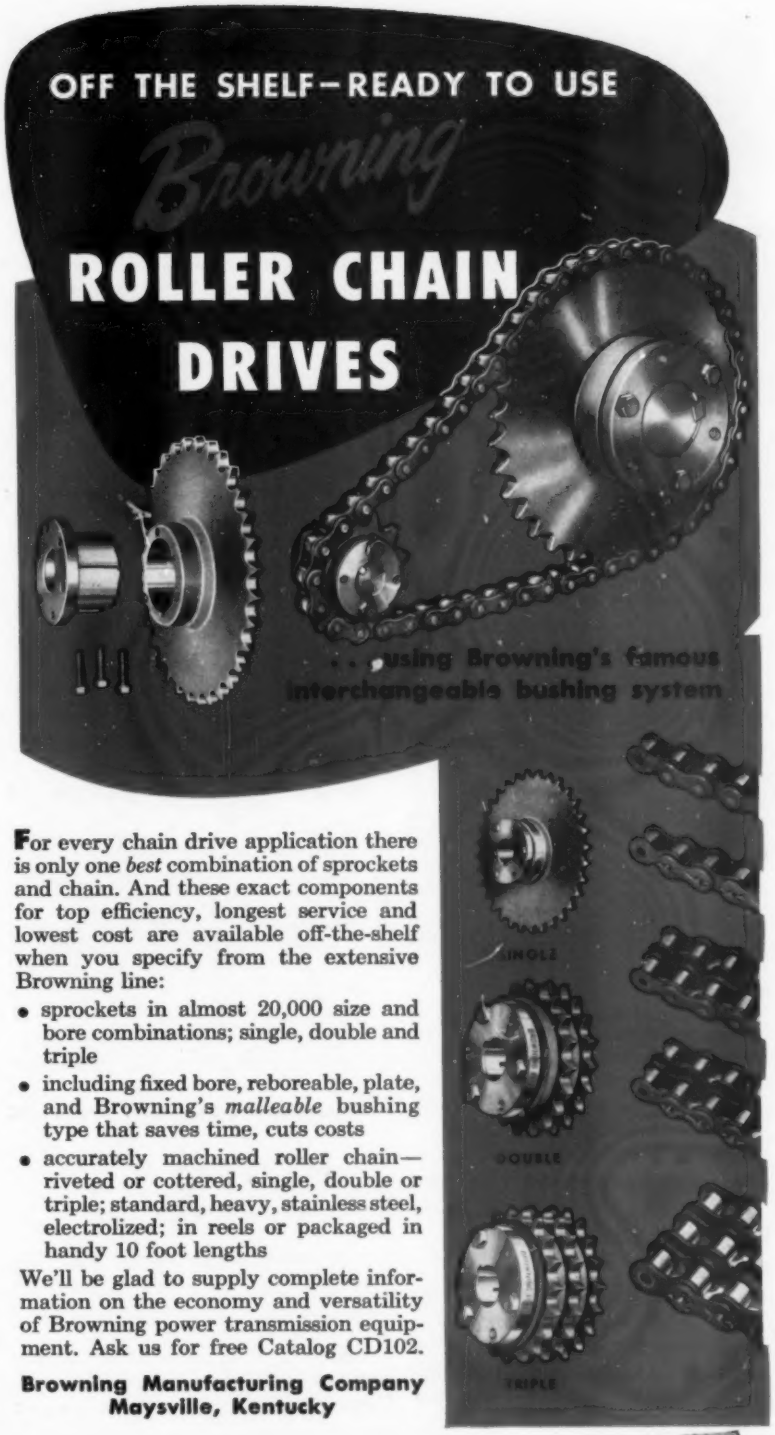
Example

Using the chart, find the speed above which an 8 in. dia., 6 in. face-width sheave should be dynamically balanced.

Answer

1400 rpm, when overhung; 2800 rpm when mounted between bearings.

If you find this answer unreasonable, select a new base for the chart and try again. Nothing will keep the chart or formula from showing that wider face pulleys need more dynamic balance at lower speeds than narrow face pulleys.



For every chain drive application there is only one *best* combination of sprockets and chain. And these exact components for top efficiency, longest service and lowest cost are available off-the-shelf when you specify from the extensive Browning line:

- sprockets in almost 20,000 size and bore combinations; single, double and triple
- including fixed bore, reboreable, plate, and Browning's *malleable* bushing type that saves time, cuts costs
- accurately machined roller chain—riveted or cottered, single, double or triple; standard, heavy, stainless steel, electrolized; in reels or packaged in handy 10 foot lengths

We'll be glad to supply complete information on the economy and versatility of Browning power transmission equipment. Ask us for free Catalog CD102.

Browning Manufacturing Company
Maysville, Kentucky

For more information circle No. 3 on the Reader Service Card

LITERATURE *on drives and components*

Industrial universal joints

Illustrated design catalog IJ320-1 is a complete guide to the selection of needle-bearing universal joints for agricultural, industrial, marine and irrigation applications. The 16-page booklet lists torque ratings, operating speeds, slip joint movement allowances, maximum operating angles, and physical and mounting dimensions for the entire range of standard Spicer universal joint assemblies.

Dana Corporation, Toledo, Ohio.

Circle number 100 on reader service card

Variable-speed drives

Help in the selection of variable-speed drives, motor pulleys and transmissions is given in eight-page bulletin G-5812. The bulletin includes mechanical construction features, condensed drive specs, available speed variations and accessories.

Reeves Pulley Co., Div. of Reliance Electric and Engineering Co., Columbus, Ind.

Circle number 101 on reader service card

Gears

Gearing of all sorts, including spur, helical, bevel and miter, worms and worm gears, splining, lead and feed screws, are described in illustrated eight-page bulletin.

The Adams Co., Dubuque, Iowa.

Circle number 102 on reader service card

Instrument and control switches

The switches described in bulletin 6162 are available as either maintained or spring-return contact types. They're used in conjunction with circuit breakers, transformer tap changers, motor-operated rheostats, instruments, and other electrically controlled apparatus. They're rated for 20-amp continuous capacity with 600-v insulation. The eight-page bulletin is well-illustrated, and describes application and construction, and gives ordering information.

Allis-Chalmers Mfg. Co., Milwaukee, Wis.

Circle number 103 on reader service card

Worm gear reduction units

These worm gear reducers are made in England by John Holroyd and Co., and sold in the U. S. by De Laval. This illustrated 36-page catalog, No. 5016, gives full details on the line, including capacities, operating curves, dimensions and specifications.

De Laval Steam Turbine Co., Trenton 2, N. J.

Circle number 104 on reader service card

Torque wrench tester

Catalog sheet describes precision, self-contained instrument, certified accurate within 1 percent of full scale reading. Detailed specs on six models, plus design and application information, are included.

Skidmore-Wilhelm Manufacturing Co., Cleveland, Ohio.

Circle number 105 on reader service card

Right-angle gearmotors

Integral gearmotors, combining the motor and worm gear reducer, and available in ratings from 1/3 to 30 hp, single reduction, with output speeds of 23 to 280 rpm, are described in four-page bulletin 3050. Cutaway and engineering specs are included.

The Louis Allis Co., Milwaukee Wisc.

Circle number 106 on reader service card

Flexible coupling

Metro-Flex coupling, for transmission of high torque or high speeds with high torsional rigidity and minimum blacklash over a wide temperature range, is described in catalog sheet. Prices are included.

Metron Instrument Co., Denver Colo.

Circle number 107 on reader service card

Ball screws and splines

Illustrated six-page catalog 58 shows applications of ball screws and splines, includes design considerations and standards, and dimensions and critical speeds.

Beaver Precision Products, Inc., Clawson, Mich.

Circle number 108 on reader service card

Power transmission equipment

Catalog G-58 covers a complete line of power transmission equipment. Sizes, operating figures and examples of use are given for flexible couplings, variable-speed pulleys, belts and sheaves, motor bases, variable-speed transmissions, gear reducers and universal joints. Illustrated; 16 pages.

Lovejoy Flexible Coupling Co., Chicago, Ill.

Circle number 109 on reader service card

Electric clutch

Maxitorq electric clutches and brakes are fast-acting and provide excellent remote control performance, making them suitable for punched tape or other automated types of operation. Illustrated four-page bulletin No. 90 describes the 9000 series of clutches. These clutches may be controlled either by varying voltage or by on-off switching.

Carlyle Johnson Machine Co., Manchester, Conn.

Circle number 110 on reader service card

Worm gear sets

Designers' aid to the selection of worm gearing and calculation of bearing loads is contained in 38-page catalog 5000 describing the De Laval line. Sections are devoted to worm and gear data, standard worm, gear and worm mounting dimensions, and horsepower ratings. There is a useful table for the quick determination of capacity of round shafts in either torsion or bending; capacity is given both in terms of torsional moment and of horsepower per hundred rpm.

De Laval Steam Turbine Co., Trenton, N. J.

Circle number 111 on reader service card

FACTS AT YOUR FINGERTIPS

Your source for copies of any item mentioned in these pages is as close as the Reader Service Cards bound into this issue. Fill them out and mail; no postage needed.

Worm gear speed reducers

Double-reduction, hollow-shaft, worm-gear speed reducers are subject of 12-page illustrated catalog HSDR-58, which covers all parts indexes, unit dimensions, dimensions for high-speed and slow-speed shaft bores, plans and elevations of all shaft arrangements, and tables of weights for Series STD torque arm and Series SFD flanged mount types. Catalog also contains complete horsepower, torque and overhung-load ratings and AGMA Service Factors for selecting worm gear reducers.

Winsmith, Inc., Springville (Erie County), N. Y.

Circle number 112 on reader service card

Planetary gears

Epicyclic-type gear for heavy-duty industrial applications is described in four-page bulletin 2400. Large-size cutaway illustrates special features of this gearing which is based on German design. Selection curves and dimensional data are included.

De Laval Steam Turbine Co., Trenton, N. J.

Circle number 113 on reader service card

V-belt drives

New line of smaller, lighter, less expensive Dyna-V V-belt drives is described in illustrated 44-page bulletin A-695. Useful tables are included for drive selection and give horsepower capacities, belt speeds, center distances, sheave diameters, etc.

Dodge Manufacturing Corp., Mishawaka, Ind.

Circle number 114 on reader service card

Universal joints

Features of Atlas universal points, including dimensions and suggestions for use, are covered in eight-page illustrated bulletin.

The Gray & Prior Machine Co., Hartford 3, Conn.

Circle number 115 on reader service card

Reversing transmission

Bulletin describes small, low-cost, reversing transmission now being mass-produced in the U. S. Transmission is designed for riding lawnmowers and other vehicles using engines up to 5½ hp.

J. B. Foote Foundry Co., Fredericktown, Ohio.

Circle number 116 on reader service card

They are made to provide smooth, more efficient transmission of power and are available from stock in 13 sizes with bored or solid hubs ranging from .375" to 4.000". Special bores, bores with keyways or setscrews are available upon special order.

The close limits to which all parts are held assure maximum load carrying capacity with durability and long life. All parts are made of preheat-treated alloy steel and are precision ground to insure high quality and interchangeability of components. Joints with hub diameters of .750" and larger have a self-closing snap ball oiler while the small pin is held in place with a self-locking snap ring. The snap ring simplifies assembly and disassembly.

Send today for Bulletin No. 527 describing the full line of ASG Universal Joints available from your nearest distributor.

AMERICAN STOCK GEAR DIVISION
PERFECTION GEAR COMPANY **HARVEY, ILLINOIS, U.S.A.**

For more information circle No. 19 on the Reader Service Card

Adjustable-speed drive

Fractional-horsepower Adjusto-Spedes are small, self-contained units combining an ac constant-speed induction motor, eddy-current coupling, and electronic speed control. The Adjusto-Spedes are available in ratings from ¼ to 1 hp, for continuous output torques from 9 to 18 in.-lb, and for full-load speeds from 1650 to 3200 rpm. Speed stability is plus or minus 2 percent of top speed in any range. Eight-page bulletin FAS 6 gives details.

Dynamatic Div., Eaton Mfg. Co., Kenosha, Wisc.

Circle number 117 on reader service card

Sealing washers

Permanent grease and oil sealing in gear boxes, automatic transmissions and power steering assemblies is said to be provided by these washers with sealant pre-applied to the underside. Four-page brochure is illustrated.

Bartite Products Corp., Everett, Mass.

Circle number 118 on reader service card

Ball screws

"The Care of Ball Screws in Operation Storage" is an excellent 16-page paper telling you how to get the most out of your ball screws. Conclusion is that ball screws require the same treatment as ball bearings for long life.

Beaver Precision Products, Inc. Clawson, Mich.

Circle number 119 on reader service card

Ball thrust bearings

Catalog 14 has 24 pages of engineering data and descriptions of various types of ball thrust bearings, as well as illustrations of various applications and helpful data for selecting bearings.

Auburn Ball Bearing Co., Rochester, N. Y.

Circle number 120 on reader service card

Centrifugal switches

These speed-responsive switches are described in illustrated four-page product bulletin 2210. Cutaways and typical applications are included.

Euclid Electric & Mfg. Co., Madison, Ohio

Circle number 121 on reader service card

Mill motor couplings

Four-page brochure No. 3 outlines design features and operation of Fast's mill motor couplings. The all-steel, self-aligning couplings are for all tapered shaft ends in sizes from ¾ to 6-⅝ in.

Metal Products Div., Koppers Co., Inc., Baltimore, Md.

Circle number 122 on reader service card

Grease cups

Lubrimatic automatic grease cup, designed to replace existing grease fittings, cups and other lubricating devices, has transparent plastic cylinder so you can see when more grease is needed. Grease is applied to cup by grease gun at fitting. Spring-loaded valve prevents over-lubrication. Two-page bulletin is illustrated.

Lubriquipment Engineers, Fort Worth, Tex.

Circle number 123 on reader service card

Split bearings

Well-illustrated catalog 58 describes company's technique for manufacturing split or fractured ball bearings, which is designed to give high performance and long life, and solve "impossible" problems. The 24-page catalog includes complete design information on various types of the split bearings.

Split Ballbearing Div., MPB, Inc., Lebanon, N. H.

Circle number 124 on reader service card

Bronze bushings

Four-page brochure shows typical applications and lists some uses of the company's product.

Superior Kendrick Bearings, Inc., Detroit, Mich.

Circle number 125 on reader service card

Speed changers and reducers

Bantam and miniature speed reducers available in a large range of standard ratios are described in two illustrated bulletins. Bulletin 97 covers Series 8 (standard) and Series 9 (anti-backlash) Metron Miniatures; bulletin 98 covers Series 10 (standard) and Series 11 (anti-backlash) Bantams. Also available is one-page catalog sheet on new Metron Bantam speed-changer kit for designers, lab technicians, etc.

Metron Instrument Co., Denver 3, Colo.

Circle number 126 on reader service card

Clutches and brakes

Magnetic-friction clutches and brakes making up the Dyna-TorQ line are described in two illustrated eight-page bulletins, MF-1 and RSF-1. Features claimed for the line include immediate response, no need for adjustment, and low operating temperature.

Dynamatic Div., Eaton Mfg. Co., Kenosha, Wisc.

Circle number 127 on reader service card

Variable-speed transmission

Catalog sheet describes simplified, variable-speed transmission for stepless speed changes up to an 8:1 ratio.

Teeco Transmission Co., Portland, Ore.

Circle number 128 on reader service card

Conveyor speed reducer

Eight-page illustrated bulletin describes speed reducer designed mainly for conveyor applications where a vertical output shaft is needed. Torque curves, selection procedure and dimensions are given.

Anchor Steel and Conveyor Co., Dearborn, Mich.

Circle number 129 on reader service card

Bevel gears

Bevel gears of various types, and clutches and coupling are illustrated in four page brochure, which also lists some of the company's customers.

Rochester Bevel Gear Co., Inc., Rochester, N. Y.

Circle number 130 on reader service card

Rotary actuator

Engineering data and description of high-torque, planetary-geared rotary actuator that incorporates limit switches and radio noise filter are included in data sheet 101-5. Actuator is suitable for aircraft as well as ground applications.

Lear, Inc., Grand Rapids Div., Grand Rapids, Mich.

Circle number 131 on reader service card

Shaft seal

Data sheet describes mechanical seal for boat propeller shafts.

Syntron Co., Homer City, Pa.

Circle number 132 on reader service card

Variable-speed pulleys

Line of five MS variable-speed pulleys, designed to eliminate freezing and sticking, are described in 12-page bulletin No. 4101. The five sheaves are rated for 2, 3, 5, 10 and 15-hp service.

T. B. Wood's Sons Co., Chambersburg, Pa.

Circle number 133 on reader service card

Winches and power take-offs

Utility winches and power take-offs that may be mounted in a single package are described in illustrated catalog sheet.

Adams Engineering Co., Solon, Ohio

Circle number 134 on reader service card

Overload cut outs

Automatic cut-out which instantly shuts off motor when overload occurs, and then resets itself automatically is described in twelve-page catalog 51.

Anchor Steel and Conveyor Co., Dearborn, Mich.

Circle number 135 on reader service card

Gears

Four-page bulletin describes company's line of gears, materials, heat treatments, and engineering and manufacturing facilities.

Akron Gear and Engineering Co., Akron, Ohio.

Circle number 136 on reader service card

Variable-speed belt

MVS variable-speed belt for V-to-V drives is built up of easily assembled links, so can be adjusted to any length. As many as 72 stock sizes can be made up from one standard package in a given top width.

Manheim Mfg. and Belting Co., Manheim, Pa.

Circle number 137 on reader service card

Electrical equipment

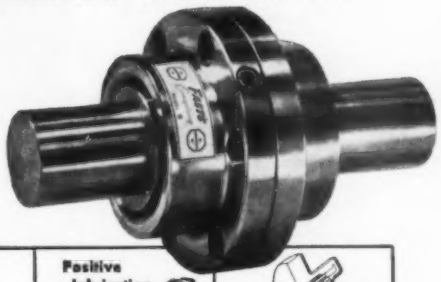
Allis-Chalmers' Electrical Review for the 4th quarter of 1958 includes articles on air switches for load tap-changing transformers, safety interlocks, contactors for medium voltage control, and reduced insulation transformers.

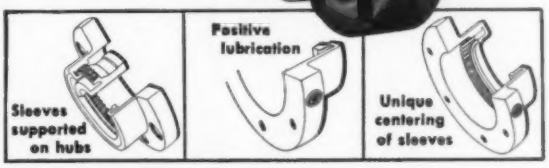
Allis-Chalmers Mfg. Co., Milwaukee 1, Wisc.

Circle number 138 on reader service card

For more information circle No. 15 on the Reader Service Card

FAST'S Model B Coupling





reduces downtime and upkeep for light-to-medium drives!

Now you can profit from the durability and economy of famous Fast's couplings in a smaller and lower-cost version—available in 5 sizes for shafts ½" to 3⅛" in diameter.

The Model B coupling gives you the same features that have made Fast's the world's leading coupling for over 35 years. You get the same trouble-free performance, longer service life and lower maintenance costs. You also get prompt delivery because stocks are on hand to meet practically every need. Free engineering service is also available.

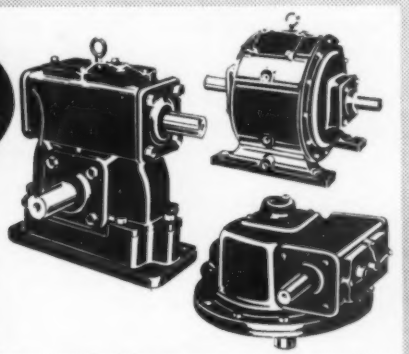
Write today for more details to KOPPERS COMPANY, INC., Fast's Coupling Dept., 5904 Scott Street, Baltimore 3, Maryland.

Engineered Products Sold with *Service*

KOPPERS

THE ORIGINAL *FAST'S Couplings*

Abart SPEED REDUCERS



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fractional to 400 hp... ratios to 10,000 to 1

For economical, trouble-free speed reduction, choose the *exact* reducer you need from Abart's *complete line.* Worm, spur and combination gear models—single or double reduction—to meet any requirement.

Compact design and rugged construction assure long, dependable service ... lower operating and maintenance costs.

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Chicago 50, Illinois

Write today for your free copy of Abart's handy pocket-size speed reducer catalog.

For more information circle No. 1 on the Reader Service Card

What causes gear tooth scoring

BY A. HUNDERE, *president, Alcor Inc., San Antonio, Texas*

GEAR TEETH FAIL in twenty different ways according to the American Gear Manufacturers Association. Many of these are only refinements of others. The types of damage have been given many different names, but the most common is scoring.

Most difficult failures for lubricants to control result from excessive metal-to-metal contact. It's amazing that excessive wear and scoring can be prevented at all since unit loading may be as high as 400,000 psi, and sliding velocity 6000 fpm at the point of contact.

Scoring has been defined as a welding and tearing action that removes metal rapidly and continuously as long as the loads, speeds, and other operating conditions remain the same. Another definition is: a phenomenon involving melting, with part of the molten metal thrown off and part smeared over neighboring areas.

Whatever the terms or definitions applied, the damage is a result of metal-to-metal contact that occurs when lubricant load-carrying ability is exceeded.

Scoring starts where the tooth surface temperature is highest. This is at the tips and bottoms of the flanks, with true involute profiles. As tooth load increases, scoring progresses toward the pitch line. With true involute profiles, wear reduces load on the scored area. This redistribution of load progresses until the scoring heals over if scoring is limited to the area of double tooth contact, and the surface is not too badly damaged. Highly-loaded gears are made with tip relief to hold the scoring tendency constant over the entire tooth surface and prevent this type of scoring.

Tooth Surface Temperatures

For scoring to occur, very high tooth temperatures must exist instantaneously. A formula for this temperature has been developed, based on conversion of friction energy into heat energy. It is

$$T_s = T_1 + K \frac{f\, W_n\, (V_2 - V_2)}{(C_1 \sqrt{V_1} + C_2 \sqrt{V_2}\, \sqrt{b_2}}$$

where T_s = temperature at tooth surface
T_1 = temperature of gear
K = a constant
f = coefficient of friction
W_n = normal load per unit length
V_1, V_2 = surface velocities
C_1, C_2 = constants which are functions of thermal conductivity, specific heat, and density
b = width at the band of contact from the Hertz formula

Sufficient data was obtained with thermo-electric measurements on a planetary gear machine using spur gears to prove the proportionality of this formula. Materials used for test gears were sufficiently different so that contact produced a thermocouple junction. Recently, similar tests were made on a Ryder gear machine and an oscilloscope to measure the emf generated. This also proved practicality of the technique. This method might be used to compare load carrying ability of lubricants.

Effect of Operating Variables

Many attempts have been made to develop an empirical equation for score limited load as a function of the many variables involved. Probably the first of these was Almen's equation

$$W_s = f\ (PVT)$$

where W_s = score limited load
P = Hertz compressive stress
V = tooth sliding velocity
T = length of action from pitch point to the end of action.

Another equation, developed from the previously mentioned tooth-surface-temperature equation is

$$W_s = \frac{1400\, Z^{1/2} - 40t}{N^{2/3}}$$

where W_s = score limited load on end of lever arm, lb
Z = viscosity in cenistokes at 60 C
t = bulk oil temperature, deg C
N = pinion speed, rpm

This equation is for an IAE machine and fits measured data within the accuracy of the test.

This article was abstracted from a paper presented at the First Gear Symposium of the American Society of Lubrication Engineers, Morrison Hotel, Chicago, January 26, 27, 1959.

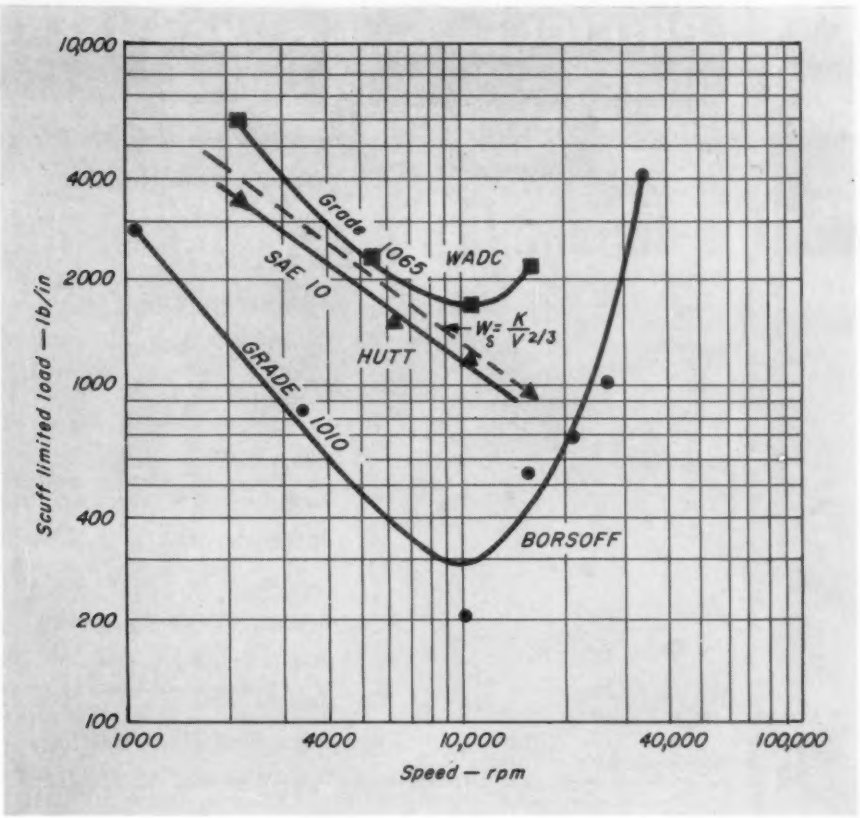

Figure 1. EFFECT OF SPEED on score-limited load determined by four different methods.

Several investigators have confirmed that load-carrying ability varies inversely as the 2/3 power of the speed. However, two recent programs show that at pitch-line velocities above 10,000 fpm, tooth load for limited scuffing increases with speed. Figure 1 compares this and other data. Although the curves in Figure 1 involve three different oils, a range of oils was tested and the shape of the curve found to be essentially independent of the oil. Variations in curve shapes must, therefore, result from differences in test rigs or gears. Increase in load-carrying ability with speed is due to hydrodynamic load-carrying ability increasing more rapidly than increased rubbing velocity reduces it.

Effects of surface finish on load-carrying ability are controversial. Some say highest possible finish should be used. Others contend that finishes better than 35 rms are of no value. In my opinion, the lubricant helps determine the value of surface finish.

So far, no mention has been made of the effect of materials on score resistance. It has been shown that chromium and molybdenum steels have better score resistance than nickel steels. Also, additives are not as reponsive with chromium steel gears as with nickel steel. In my experience, a change from a typical aircraft gear material to a special score-resistant steel can increase load-carrying ability eight times.

It's surprising that gear designers don't follow the good lubrication practice of using dissimilar metals more often. Steel journals would not be run in steel bearings or steel piston rings on steel cylinders. But, more often than not, gears are steel on steel.

Gear Lubricant Testing

No simple test for predicting a gear lubricant's load carrying ability has so far been developed. Actual gears are used in tests. All the major aircraft and automotive companies have their own gear test rig designs.

In the aviation field, the Ryder gear machine is standard and is specified in all Air Force gas turbine lubricant specifications. There are more than 15 of these in the U. S. They are also used to determine load-carrying ability of Navy turbine oils, Specification MIL-L-17331.

For testing automotive gear lubricants, full-scale axles, such as the 3-¼-ton Army truck hypoid axle with 5.83:1 gear ratio, are used. This is specified for the L-20 and L-37 tests. The lubricant is stressed by high speeds, high torques, or a combination of both at high temperatures. Shock or bump tests where inertia loads are suddenly applied are also used.

Reference oils are also used in automotive gear lubricant testing. Two oils are used, one with a rating of 15 and the other zero. The zero rating oil is a very poor lubricant; the other is better than that required for the most severe service today. Intermediate oils are gotten by blending the two. This reference eliminates rig-to-rig variations and lets lubricant requirement for any gear applicaton be expressed in universal terms.

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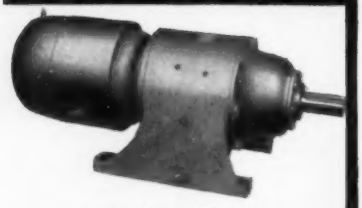

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Warner Electric Brake and Clutch Co. .....Cover 3

electric motion control facts

for IDEA MEN

Electric motion control speeds automatic cycling

This manufacturer set out to design a rugged, dependable machine that would combine simplicity of operation, virtually foolproof electrical control, and flexible setup—for performing a sequence of rapid-fire operations on wire.

Three Warner electric brakes and two electric clutches played an important part in the design of machine elements which automatically measure, cut off, mark, and strip the ends of wire segments used in modern military aircraft and missiles.

Meet maintenance objective

The simplicity with which a series of complex operations could be controlled by electromagnetic rotary drives answered one of the major design requirements—easy maintenance. Use of the Warner units not only eliminated the need for brake and clutch adjustments, it reduced assembly costs, too. And, they provided the ideal answer for controlling fast starts and stops needed in the automatic cycle.

Control spacing to close limits

One step in the cycle is marking the wire at close intervals near both ends and at wider spacings for the rest of the run. Spacing is controlled by two Warner PC-500 feed clutches which engage the fast or slow gear train (see Fig. 2). The end stampings are made as wire moves at 6 in. per sec., with intermediate markings at 30 in. per sec. Fast, precise engagement and release of the clutches easily make extremely close spacings possible.

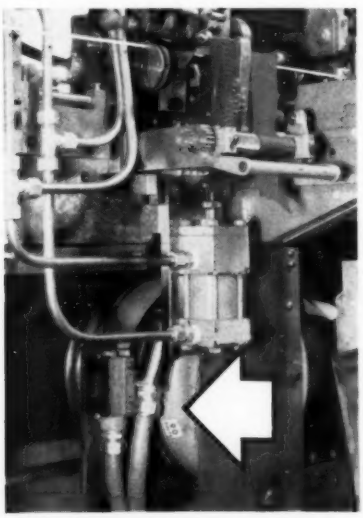

Fig. 1—The transmission that strips and cuts the wire is automatically controlled by the Warner PBC-825 electric clutch-brake.

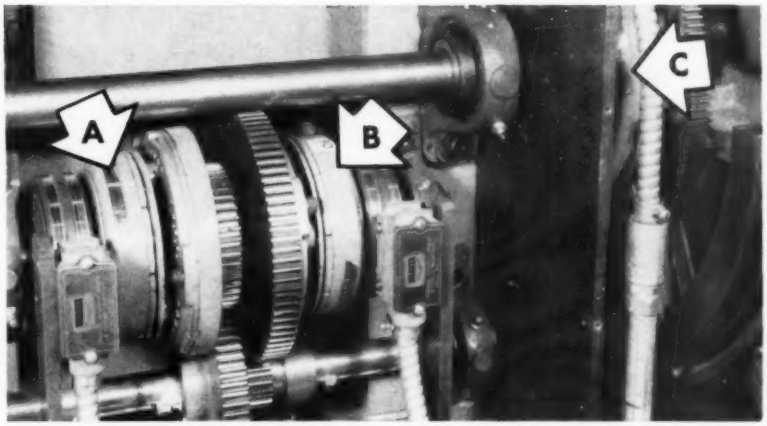

Fig. 2—Two Warner PC-500 electric clutches control wire feed roll. Armatures are mounted on drive pins to special hubs on slow- and fast-feed drive gears. Slow-speed clutch (B) is at the right, and fast-speed clutch (A) is at the left. Warner electric brake (C) assures precise stopping of roll for each index.

Measure wire segments

For cutting wire to accurate segments, a Warner PB-825 electric brake controls the feed roll. This operation is so precise it exceeds the original specifications, measuring segments to a tolerance of plus or minus 1/16 in., even on longer lengths.

The transmission that cuts and strips the wire is actuated by a Warner PCB-825 clutch-brake (Fig. 1) which also actuates the timer and sorter to place wires in the proper slot at the completion of the cycle.

If you have a machine control problem, or want to find out how *electric motion control* can improve performance of your product, talk to your Warner representative or, write for our "IDEA ALBUM" examples of how electric brakes and clutches solved complex motion control problems.

Originators of electric motion control

Warner Electric Brake & Clutch Co.

Beloit, Wisconsin

Please send: ☐ "IDEA ALBUM" Sheets; ☐ Catalog; ☐ Representative.

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